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Railway Electrical Engineer

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Elements of Practical Electricity

The function of the *Railway Electrical Engineer* is one of service to its subscribers and to be of service it must ever be mindful that these subscribers are not all on the same level as regards technical knowledge and railroad experience. Not only must the paper contain valuable information for the older and more experienced electrical man but it must also present articles which have a distinct appeal to the younger recruits in the electrical department. Many of this latter class struggle under the great handicap of insufficient education and most of the books that contain the information that would be useful to them are not read because they are too difficult to comprehend.

It is not always simple to explain electrical theory in such a way that it is easy for a beginner to understand it and when an article on an electrical subject is prepared especially for a newcomer in the railroad field, we feel that it has a place in the *Railway Electrical Engineer*. It is for these reason that we are glad to announce a new series of articles beginning in this issue, entitled "Basic Principles for the Electrical Workman." The author of this series is K. C. Graham, who is a practical electrician with years of experience. Mr. Graham was formerly engaged in carlighting work for the Pullman Company and the knowledge gained from his intimate acquaintance with this field has made it possible for him to present, in clear and direct language, those parts of electrical theory which the average workmen require. The articles will be short so as not to confuse the reader with too many facts at one time. The theory is presented in logical sequence and all extraneous matter is omitted. In short, this series will be brief and clear and will prove especially valuable to those just beginning to take up the duties of the electrical worker.

Standards for Electric Motors

The Association of Railway Electrical Engineers has drawn up standards for electric motors used for all purposes by the railroads. These standards were developed by an association committee and presented before the 1922 annual convention of the A. R. E. E. held in Chicago. Further attention has been called to the value and need for such specifications by the action of the International Technical Commission at Geneva, Switzerland. This commission, comprised of 58 delegates, representing 12 countries prominent in the electrical industry, has more recently adopted standards for electric motors which are practically identical with those developed by the A. R. E. E.

As stated in the A. R. E. E. committee report, such motor specifications are required because of the inherent necessity for railroad operating organizations to be divided and sub-divided into major and sub-departments. It is this fact that primarily forces railroads to use more substantial and rugged motors for the various services for which they are employed than those which are used in ordinary industrial service. The specifications as developed are intended as a guide to the purchaser in the selection of and to the manufacturer in the furnishing of electric motors for steam railroad service. Motors used by railroads are operated and maintained under conditions peculiar to that service and motors with a given rating, as offered to the railroads by the various manufacturers, differ widely in quality and design.

The specifications as developed by the A. R. E. E. have met with a considerable amount of approval. In speaking of them, a prominent manufacturer recently stated, "It is indeed a curious thing that the A. R. E. E. committee should have hit upon a particular definition which the electrical industry in this country failed to crystallize and which now bids fair to become not only a standard in this country, but one of international scope."

At the present time, these specifications deal only with open type motors, but at some later date it is the intention of the committee to enlarge them so as to include also semi-enclosed and fully-enclosed motors. They were published in the October, 1922, issue of the *Railway Electrical Engineer* and will also be contained in the annual proceedings of the A. R. E. E. The Electric Power Club and a number of motor manufacturers attended three open meetings of the committee during the preparation of the specifications. The members of the association, during the past few years, have been particularly active and apparently fully aware of its possibilities. In the activity of the association lies a means by which the electrical man may obtain recognition and come into his own.

Car and Locomotive Orders in 1922

During 1922 as many passenger cars were ordered by the railroads in the United States as were ordered during the preceding four years. Locomotive orders were the largest they have been since 1918. The freight car orders were eight times the 1921 figure and the total for 1922 was exceeded only twice since 1906. Practically every locomotive order of course includes complete electric lighting equipment and out of a total of 146 orders for passenger cars, 138 specified electric light, 5 gas and electric and 3 gas

light. Nearly all of the cars are of all-steel construction.

The total number of passenger cars ordered by railroads in the United States during 1922 was 2,382 as compared with 246 in 1921, 1,781 in 1920, 292 in 1919, 109 in 1918, 1,124 in 1917 and 2,544 in 1916. The total for 1922, however, was not as great as it was during the years preceding 1916. Passenger car production totalled only 676 for domestic service, this being the smallest figure for any recent year except 1919 when the production was 391. The reason for the limited number of cars built last year was that there were few orders in the hands of the builders at the beginning of the year. Construction in 1923 should greatly exceed that in 1922 because of the orders which have been placed at quite regular intervals during the year and there are good prospects for a continuation of the 1922 level of business in new orders.

Approximately 2,600 locomotives for domestic service in the United States were ordered during 1922. The total for the year was ten times as great as for 1921, when 239 were ordered, but the 1922 figure was not large as compared with many years preceding 1918. During the past few years, the orders for domestic locomotives were as follows: 1921, 239; 1920, 1,998; 1919, 214; 1918, 2,593; 1917, 2,704. It may therefore be said that the year 1922 was characterized by a resumption of locomotive purchasing on a large scale for the first time since 1918. The fact that locomotive buying is continuing is evidenced by the placing of large orders in December and even in the last week of that month when there is usually a falling off because of the holidays. As in the case of the passenger cars, locomotive production was comparatively small in 1922 as the bulk of the orders were placed in the latter part of the year.

It has been pointed out at various times in the past few years that the railroads have not purchased enough new equipment to meet the demands of increased traffic. It is also true that traffic did not increase at as great a rate as many had expected. The fact remains, however, that the purchases for several years fell far short of the requirements, and the activity during 1922 indicates that the necessary movement is on foot. If the progress is not retarded by regulation, strikes or other unforeseen happenings, it is fair to assume that a banner year for railroads is in prospect.

Advantages of Good Lighting

The recent meeting of the Society of Terminal Engineers, held at the Engineering Societies' Building in New York, emphasizing the importance of good lighting in railroad yards, shops, and engine houses. There is perhaps no single factor involved in the efficiency of night railroad operation so important as good lighting and yet the number of instances where the illumination is adequate is remarkably small. The lack of good lighting is, of course, due to the fact that insufficient consideration has been given to the subject. It is too common a fallacy to assume that any space is sufficiently illuminated simply because some source of light is furnished. The subject is too often dismissed with scarce consideration for the requirements that have to be met.

The truth is the economy of good illumination is not appreciated to anything like the extent it should be and until those who are responsible for the installation of lighting systems come to a full realization of the factors involved in the problem, the highest efficiency in night operation cannot be attained. It matters not whether the place be in the classification yard, engine house, shop or elsewhere, the work performed by employees at night is unquestionably influenced by the lighting conditions under which they must work. If the lighting is good, operations will be carried on expeditiously; if it is poor, all movements are sluggish and inefficiency abounds. While it is of course incorrect to say that efficiency of operation increases in direct proportion to the increase in illumination, it is not incorrect to say that operations requiring artificial light become more and more efficient as illumination is increased until a point is reached where an abundance of light is furnished.

Not only is sufficient illumination a powerful factor in speeding up operation but it is also one of the greatest safeguards which surround the workmen. Statistics show that approximately one-fourth of all of the injuries suffered by workmen are due entirely to inadequate lighting. An increase in lighting is often opposed by those whose motive it is to curb expense, but unless all of the factors of the problem are carefully considered, it may easily be possible to spend many times more for certain operations than would be required if adequate illumination were supplied. Unfortunately, an improvement in lighting does not always make itself manifest instantly, but a comparison of the records over similar periods of time, before and after such improvement has been made, will invariably show that the increased lighting is a very profitable investment.

In the consideration of any lighting improvement, it is an excellent idea to have engineers from some of the lamp companies look over the ground. From their experience in dealing with similar problems, they are usually in position to suggest a practical solution for most of the difficulties that are liable to arise. It is natural enough to keep the desired results at the lowest cost and it is no reflection on the ability of any railway electrical man to summon to his assistance those who are daily in touch with the problems of efficient illumination. In short, good lighting facilities can be obtained at a cost which is in no way extravagant but which, on the contrary, is certain to prove a profitable investment.

New Books

Handbook for Electrical Engineers—By Harold Pender and W. A. Del Mar, second edition, 2,263 pages, illustrated with diagrams and tables, 5 in. by 7 in., bound in fabrikoid. Published by John Wiley & Sons, 432 Fourth Avenue, New York, N. Y. Price $6.00.

Theoretical matters dealt with in the book have been segregated into separate articles and in the same way articles dealing with practical matters are also kept separate. All articles are arranged alphabetically but a topical list is provided as a guide for consecutive study. Bibliographies are included and cost data given. It is essentially a handbook for the practicing engineer. The second edition is somewhat larger than the first and a number of entirely new articles have been added. Many of these have been entirely rewritten and all subject matter contained in the book has been thoroughly revised. More than 40 specialists have been called upon to assist the editor.

Electrical Equipment in Large Mail Terminal

Push Button Stop and Start, Interlocking Control and Indicator Lamps are Features of System

By Ralph G. Lockett

View of Post Office from Van Buren St.

THE large railway mail terminal recently put into service as a part of the Union Station at Chicago at a cost of $4,000,000 clearly demonstrates the tendency toward close co-ordination of the postal service and railway transportation in the handling of mail.

The new terminal will be used for a variety of postal operations but all of them are closely related to the receipt and dispatch of mail, either at the Union Station or at the other railway stations in Chicago.

Four independent groups of men—the mail terminal employees, the employees of the postal station, the Union station mail handlers and the employees of the mail street vehicles are concerned in the operation of the terminal but the duties of the several groups and the portion of the building assigned to them is so clearly defined that little if any opportunity will be afforded for confusion or interference.

An idea of the magnitude of the operation carried on in this terminal will be gained from the fact that it is capable of handling 3,000 tons of mail in 24 hours. The building extends along the east side of the Union Station property for 796 ft. between Van Buren and Harrison streets. It has a width of 76 ft. and a height of seven stories and basement. Besides the frontage on Van Buren street and on Harrison street which is relatively narrow, a private driveway is provided along the full length of one side. Like the large freight terminals of the Pennsylvania, the Chicago & Alton and the Chicago, Burlington & Quincy, the mail terminal is of the two-level type served by platform tracks on the lower level and a teamway on the street level, the driveway mentioned above affording 580 ft. of clear tailboard space, or enough for 60 street vehicles at one time. The track level has platforms adequate to serve 61 cars, while the basement affords communication by means of tunnels with cars at Union station platforms remote from the mail terminal.

Operation of the Terminal

All classes of mail made up in bags for mail cars on lines served by the Union station are received on the street level at the north end of the building where 18 chutes are available for transmitting the mail sacks directly to the track or basement level to be sorted and loaded on platform trucks to be hauled direct to the mail cars of the various trains. Incoming mail on trains entering the Union station is sorted on the track or basement level, loaded on trucks and delivered to upper floors of the building by elevators. Sacks of mail properly sorted for other railway stations or for Chicago city delivery are delivered to the street level floor and trucked to the driveway space near the south end of the building for transfer to the street vehicles.

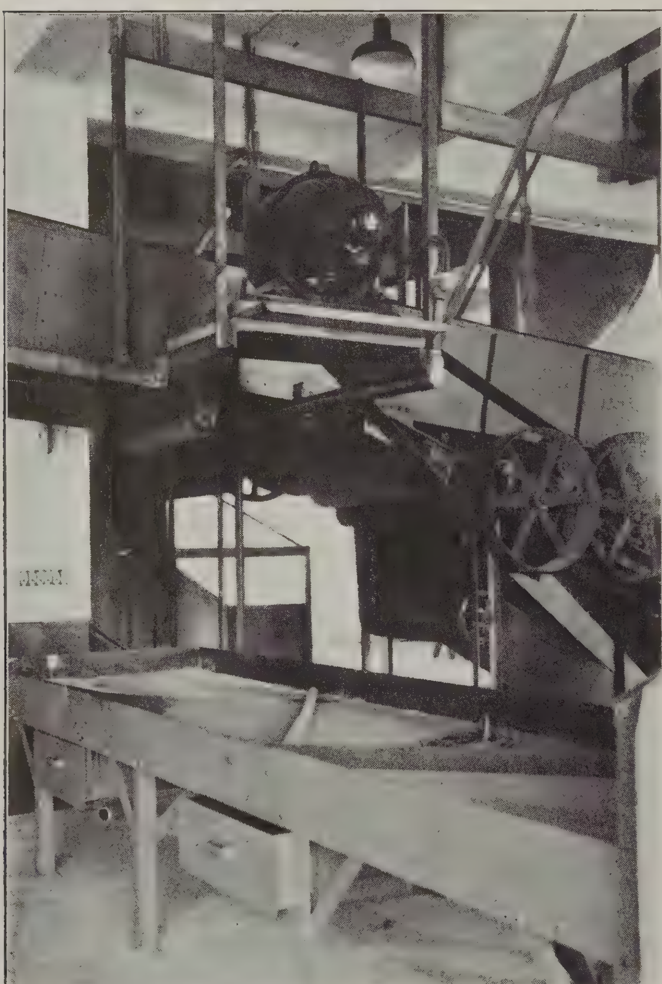
By far the greater portion of the building is devoted to the railway mail terminal service, the purpose of which is the receipt, classification and dispatch of all mail coming from the street or from the trains which is not received in sacks properly classified for delivery to trains or street vehicles. Such mail is received from the street along the middle portion of the driveway space and from trains on the basement or track level. From these points of receipt it is delivered to the upper floors of the building for the necessary work which consists of one or more classifications, resulting in the sacking of the mail properly segregated according to the various railway mail routes or street delivery. Another separation introduced is to provide that second-class matter, catalogues and small parcels, are not placed in the same mail bags with large, bulky packages. The first named are classified on the fourth and fifth floors and the other two on the second and third. Separation into these two classifications is made on the first floor or, insofar as possible, by persons or companies delivering mail to the terminal.

Second-class, catalogues, and small parcelpost packages delivered in sacks are placed on 3-ft. by 8-ft. platform trucks, taken to the elevators and delivered to the fourth or fifth floors, according to a general classification. Sacks containing bulky packages, if classified according to states, are placed on 8-ft. trucks and delivered to the third floor. In general, mail delivered to the upper floors on the 3-ft. by 8-ft. trucks is transferred according to classification onto smaller trucks of a capacity of about 20 sacks each and delivered on these to the various state sections on the floors for classification.

The classification of bulky parcelpost mail received at the station in unclassified form is handled through the aid of special classifying equipment, for which purpose the work is greatly facilitated by having the mailer deliver it to the terminal in tilting box trucks which may be rolled off of the street vehicle with the minimum of effort. These tilting box trucks are taken to two belt conveyors where they are dumped onto the conveyors for delivery up an incline to the third floor. Here the packages pass through what is known as a separation unit. This consists of a series of belts arranged in such a fashion that postal clerks standing on platforms between these belts may pick up packages from the feed belts and throw them onto other belts to separate them for certain general classifications. In addition two belts are provided

to receive mail for another primary classification. These two belts deliver this material up an incline to the fourth floor, where the second separation unit will be provided for the separation of the mail into other general classifications. The mail separated on the classification belts in the separation units on the third and fourth floors is transmitted through openings in the floors and over other belts to working tables on the second floor and third floors, respectively.

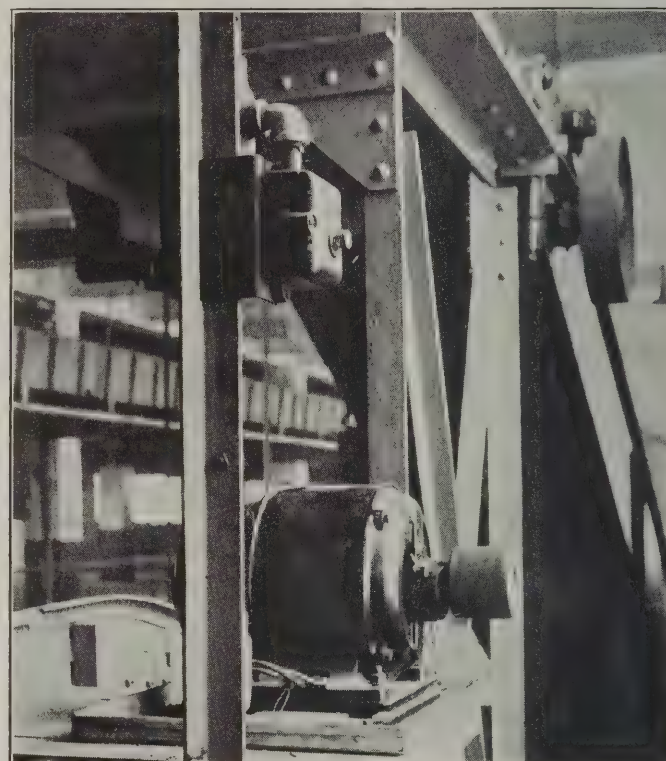
The final separation and classification of all mail handled by the terminal forces is made at tables on the second, third, fourth and fifth floors where the mail is placed in sacks and properly marked, ready for delivery to the Union station forces on the track floor or the basement, or to the street vehicles on the street floor for delivery to various parts of the city or to other railway stations. This movement of the mail sacks from the second, third, fourth and fifth floors, to the street floor, the track floor or the basement, is accomplished with a minimum of manual labor and without the use of the elevators. Close to the ceilings directly below the second, third, fourth and fifth floors, five longitudinal conveyor belts (20 in all) are provided, extending practically the entire length of the building and with which communication is afforded by means of 60 openings through each of these floors at approximately uniform intervals; these openings are of sufficient size so that mail sacks may be dropped onto the belts readily. Each of these 20 conveyor belts is connected with one of five double spiral chutes. One of these is located at the north end of the building, one near the middle and three at the south end. All of these chutes except two extend to the basement and the two in question are provided with delivery spouts on the street floor.



General View of Motor Location and Belt Arrangement

Electrical Equipment

Each belt is driven by a geared double drive pulley, the main pulley being 30 in. in diameter. The individual drives are belt connected to Westinghouse semi-inclosed multi-pole plain shunt motors. Power is received from a sub station in the building. Horse powers range from 1.14 on the smaller belts to 12.50 on the larger, there being eight different ratings on the motors and their individual controls. The minimum speed of each belt was specified by the Post Office department, and the horsepowers computed by the conveyor manufacturer, taking into consideration the maximum speeds required. Seven of the motors and controls furnish 75 per cent speed increase by shunt field weakening and the remainder give 25 per cent.



One of the Small Motors With Stop Button

The control equipment for each conveyor motor consists of a magnetic starter with current limit acceleration, equipped with two magnetic main line contactors, overload relay, accelerating contactors, field weakening relay, field rheostat, pilot fuses, and circuit breaker. The circuit breakers require mention, being supplied in addition to the main contactors and overload relay, and are double pole, independent arm, instantaneous trip overload type.

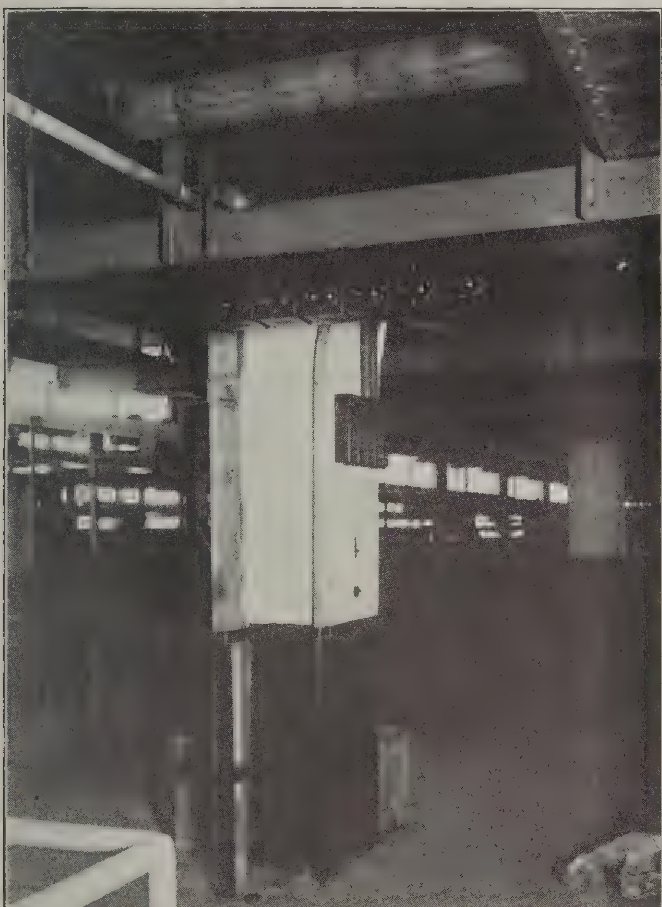
These control units are arranged in six groups or switchboards, mounted on special angle iron frames. In making up the switchboard combinations, the unit idea is not sacrificed, since they are designed to afford con-

venient and ready replacement of any control by a spare unit kept in reserve.

Motors and Control Circuits

Twenty of the 71 motors and controls are grouped in the third floor separation unit; 15 are in the fourth floor separation unit, and the remaining 36 drive individual belts, some of which are interlocked.

Current limit acceleration is provided by magnetic lockout switches, having no restricted magnetic area in the magnetic circuit, this stipulation being contained in



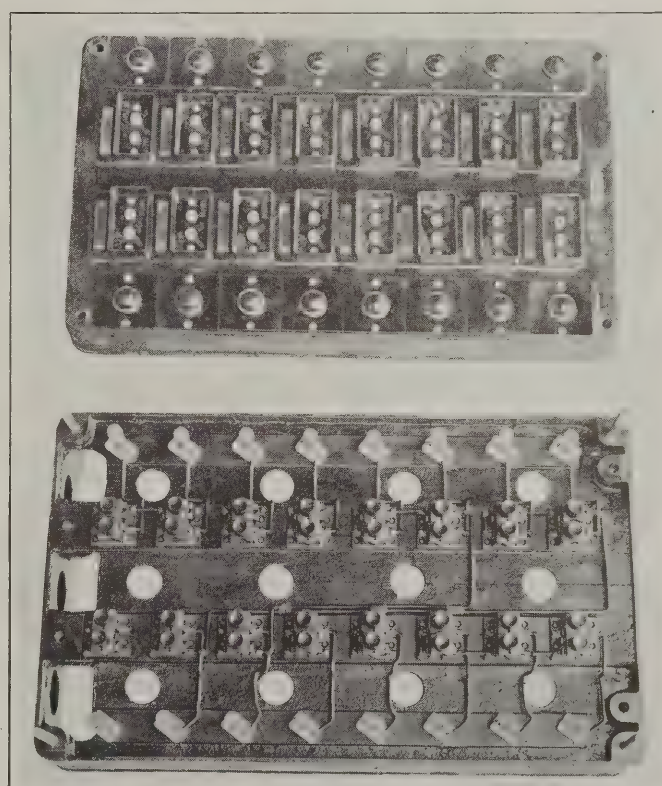
Remote Control Push Button Station With Lamps Indicating Which Belt Routes Are in Operation

the Post Office department specifications. Each switch has two series coils, one for the closing operation of the switch, and the other for lockout during acceleration. After the lockout coil has functioned and the switch is closed the lockout coil is automatically cut out of circuit. The last accelerating switch acts to close a shunt contactor of the same capacity as the main contactors, this shunt contactor cutting out all accelerating switches and resistances. The smaller controls have one accelerator only which acts to bring the shunt contactor in with it, after which it becomes inactive, and opens.

Interlocking circuits are provided between all controls of any one group, and act to prevent group motors from being started in improper sequence. These circuits are taken care of only on the last accelerator, instead of on the main contactors, of all the master controls, so that complete circuits for starting dependent motors are not made until previous belts are up to normal speed. In general, all controls of a group are designed so that motors may be started only in a given sequence, preventing pile-up of packages or mailbags where they are fed from one belt to another or through chutes.

Each unit is controlled from at least one start station, with numerous stop stations located according to stipulations of the Post Office department. The push button grouping follows the grouping of the system itself. Two 20 station switch gangs located at the ends of the separation unit on the third floor provide start and stop stations for each motor in that unit together with an individual indicator light which flashes on with the closure of the last contactor on each control unit. Similar gang stations provide the same functions for the fourth floor separation unit. The 20 station switch stations are similar to that shown in one of the illustrations except for greater length and greater number of switches. All stop elements in these gangs may be locked in the off or "safe" position by a quarter turn of the button, as indicated on the face of the station.

There are, in addition, separate stop only stations for each separation unit motor, located along the length of the unit, within reach of the operators on the platform. These stations may also be locked in the safe position, and any one of these stop buttons, when locked open, prevents

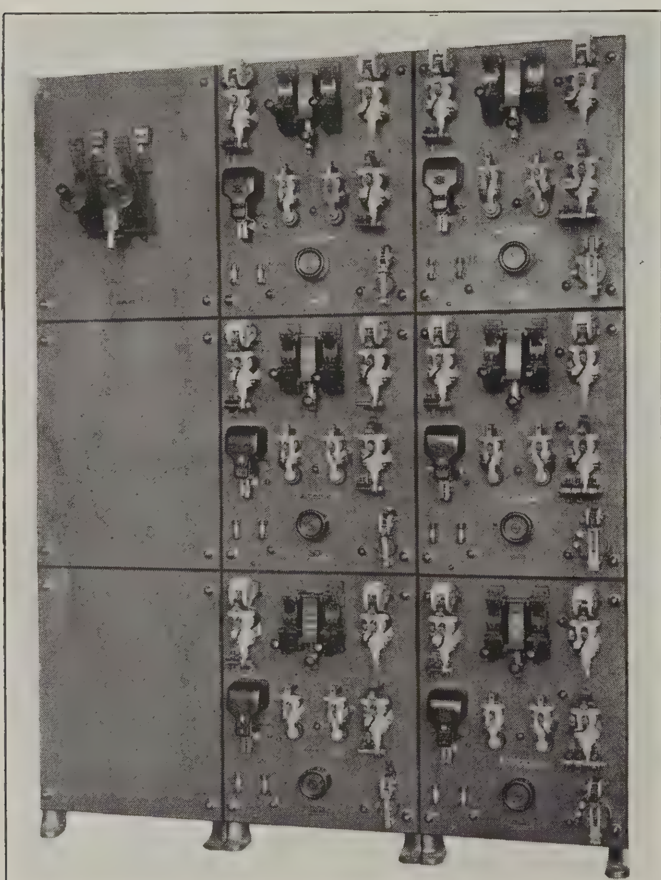


Separation Unit Gang Push Button Station. One of These at Each End of Unit Controls All Motors in the Unit

starting of its motor. Since all stop buttons are arranged to shut down all motors of an interlocked group, a "safe" setting on any one of these buttons, whether in one of the gangs or in a separate station, prevents starting of its group, since the main contactor coil circuit on the master is held open. Similarly, a safe stop station is provided at each motor, this provision applying to all motors in the system. Therefore, all wiring to a given motor may be rendered dead on both sides of the line by locking the motor station open.

Individual belts not in the separation units serve various purposes, and whether operating singly or interlocked with others, are provided with individual combined start and stop stations located at one hundred foot intervals along their length. For convenience, these stop stations are not provided with the locked open feature, since an open button would be difficult to locate it inadvertently left open, due to the length of the belts and number of stations. However, these off buttons also stop all motors of a group, regardless of which control circuit is selected in the group. Duplicating the indicators in the gang stations, individual double faced bullseye indicators are mounted in the center of the building on the various floors for all ceiling or horizontal conveyors, so that the operators may have proper supervision over belts out of sight. These are also controlled by the last accelerator.

All indicator lights serve a double purpose. They show at all times which belt motors are in operation at normal speed, and also aid in starting up an interlocked group by giving the operator a check on the closing of interlocking circuits. A dependent motor may be started as soon as the master next ahead in sequence has come up to speed, and the buttons are grouped to make the following of proper



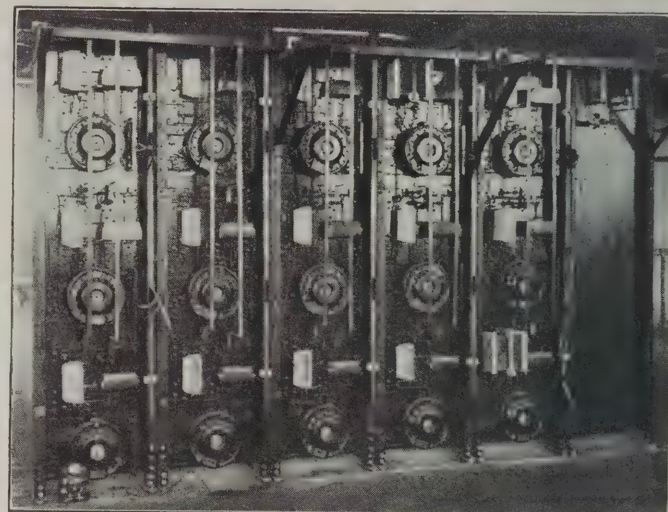
One of the Smaller Type Switchboards

sequence convenient to the operator, since he causes each succeeding light to flash on by momentarily depressing the various start buttons in regular order.

All push button circuits are energized from individual pilot control fuses, feeding behind the individual double arm circuit breakers, and where two or more sets of control circuits must be handled simultaneously in the interlocking scheme, they are taken care of on the master panels without any "common" or cross connections. This means that the entire pilot circuit for a given control is at all times energized behind the control fuses on that control and there is therefore no opportunity for one control circuit to receive energy from another. When an individual circuit breaker is open, all wiring in connection with that circuit breaker is dead on both sides of the line.

Control Boards

Each motor control unit is mounted on a separate piece of genuine Monson slate 22 in. wide, 28 in. high and



Rear of Controller Panel Board During Construction. All Boards Are Enclosed in Wire Grating in Finished Installation

1½ in. thick, with natural oil finish. Two control boards made up of these units are located on each of the second, third and fourth floors with the motor controls for the first floor mounted on the boards on the second floor. The number of units on the several boards ranges from six on the No. 6 board located on the south end of the fourth floor to 15 on board No. 5 which is mounted on the north end of the same floor. Blanks for one or two additional controls are provided on each switchboard and there is, in addition, a circuit breaker section on each board which provides for feeding all the controls on that board. This switchboard circuit breaker is in addition to the individual circuit breakers on the unit controls and is of the same general type; double arm independent acting, instantaneous trip overload. Each motor is therefore protected by its individual circuit breaker which is equipped with instantaneous trip overload, the switchboard circuit breaker, which would protect against short circuit conditions, and an inverse time limit relay working in conjunction with two independent main line clapper switches which also disconnect both sides of the line.

All control circuits are energized through individual pilot fuses located on the control panels, feeding behind the individual double pole circuit breakers. Thus, the entire pilot circuit for any control is energized at all times behind the fuses on that particular control, and there are no common or cross connections. Therefore, if both poles of an individual circuit breaker are open, all wiring in connection with that control is dead on both sides of the line. When two or more interlocking circuits are handled on a unit which serves as a master or submaster, these circuits are handled simultaneously without

interconnection. This means that each control circuit may be traced from one pilot fuse, through the various interlocks and stations (in some cases onto other switchboards on different floors), and back to the other fuse, without involving any other circuit.

Panels are so designed and mounted on the switchboard framework that any one unit may be quickly removed and replaced by the spare kept in reserve. There are eight horsepower ratings on the 71 controls making up this installation and eight spares, one for each horsepower rating. Each spare is arranged to take care of any or all of the interlocking features which may be present on any control panel of that horsepower rating.

Power is delivered to each control section or unit by busbar connections on long circuit breaker studs extending to the rear, and all outgoing connections are led to an asbestos lumber terminal panel in the rear of each slate section. The entire control is mounted on the slate proper, so that nothing need be disconnected from the frame when making a change-over. By taking off the two busbar connections, removing the outgoing leads and removing four mounting screws, an entire control section may be removed and the spare substituted.

Horizontal busbars extend across each control board at the top and in the rear according to general practice and a pull box or cabinet for the outgoing power and interlocking wires is mounted directly above the busbar structure. The entire switchboard, front and rear, is then enclosed in a wire mesh cage, making the board a self-contained unit.

Each slate panel is marked with a brass engraved lacquered nameplate, giving the name of the belt or belts which the motor in question controls. Some of the endless conveyors serve a double purpose, being known by one number on one floor and by another number on another floor either above or below. In such cases the control in question is marked with two engraved plates, giving both belt names. Each push button station is marked with an appropriate legend and the various elements in the gang push button stations carry brass lacquered nameplates to agree with the markings on the slate panels.

Wiring Connections

Connections for this installation were necessarily arranged to give the interlocking features by sections or switchboards. Due to the large number of interlocking connections and also to the location and grouping of the controls concerned, it was not possible to segregate any one complete interlocked group on one connection diagram.

Six diagrams were used to show the arrangement of connections on the six switchboards and the wiring to the gang push buttons and individual stop buttons. Arbitrary numbers were assigned to the interlocking wires, the hundred digit of each number indicating the switchboard number carrying the pilot fuses supplying the energy for that wire. Each control circuit can be traced through the pilot fuses supplying energy and there are no cross connections between individual control circuits.

Inspection of the installation indicates that particular care has been taken to safeguard both the operators and equipment. Stop buttons are provided in sufficient number at all points and through the interlock scheme, entire groups may be conveniently and quickly shut down. The distribution and general control scheme are adequately protected against overload or any other abnormal condition, and due to the current limit type of acceleration employed, the belts can be gradually accelerated whether loaded or unloaded. Each motor is started on full strength shunt field and then automatically accelerated to the speed for which the shunt field rheostat is set. Therefore should a shutdown occur, a restart secured on any one of the start buttons, gives the same operating speeds on the conveyors as obtained previously. There are 173 start and stop buttons, 106 stop lock buttons and 33 large indicating lights, approximately 40,000 feet of control and main circuit wire installed in connection with the six switchboards. If all belts were operated at one time approximately 400 hp. would be required to operate them at maximum speed fully loaded.

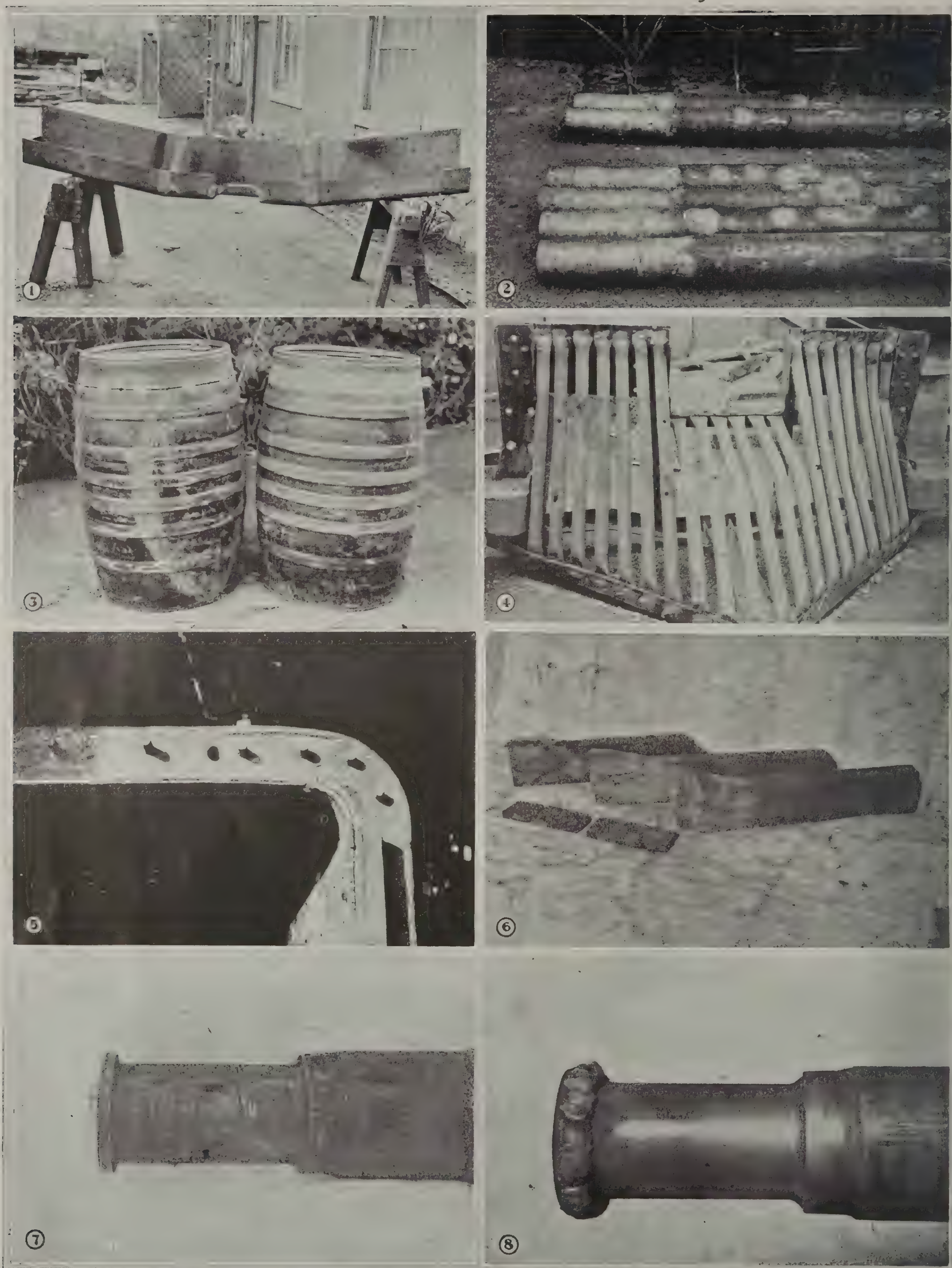
The mail handling equipment was manufactured and installed by the Lamson Company, Boston, Mass. Westinghouse motors are used and the controller equipment, push buttons, and indicator light units were furnished by Cutler-Hammer Company, Milwaukee, Wis. The installation of the electrical equipment in connection therewith was installed under a sub-contract by the Oscar M. George Company, Chicago.

Measuring Light

The fact that hollow spheres can be used for measuring the total light given by a lamp has been known for some time, but recently their use has increased very greatly because the new gas-filled lamps which have an irregular shaped coil filament can not be very well measured with any other apparatus. Consequently, every factory and laboratory which wishes to make accurate measurements of such lamps has to have a sphere.

The Bureau of Standards at Washington has, therefore, issued Scientific Paper No. 447, describing a large sphere built at that Bureau and giving a complete explanation of the theory of spheres as light measurers and of the precautions which must be taken in order not to make mistakes when using them. The particular sphere described is 88 inches in diameter and weighs about a ton, but for different purposes spheres from 3 inches to 10 feet in diameter have been used. Some of these, for example, are made as attachments for pocketsize "Illuminometers" and are carried about to measure the reflections from walls and ceilings and from samples of paper, paint, and other materials, while modified forms on a large scale have been used to catch the beams from full-sized army searchlights and measure the light in them.

To measure lamps in many different directions would require an enormous amount of time and work, and several ingenious devices to get the same result with less labor have been invented. One of the simplest and most satisfactory of these is the integrating sphere mentioned above. This is simply a large, hollow, white-walled ball, inside which a lamp can be placed with a small window so that the brightness of the inside wall can be observed. The light is reflected back and forth between different parts of the white surface, and the sphere has the peculiar property that every part of its surface automatically sends to every other part exactly the right fraction of the light, so that the reflected light falling on the window correctly represents the total amount of light produced by the lamp.



Specimens of Welding Work Done in the Southern Pacific General Shops at Sacramento

Welding Practice on the Southern Pacific

How Electric Arc and Gas Welding is Extensively Used in the Sacramento General Shops

ALTHOUGH much has been written concerning the application of electric arc and oxy-acetylene welding we have yet much to look forward to, as during the last few years an unusually rapid advance has been made in both of these methods of welding and they have now become recognized as an art very essential to many industries and particularly essential to the railway industry.

One instance is the making of car end sills for repairs to steel cars. These have deep flanges and are of irregular shape. It would be a difficult and expensive operation to flange these sills by hand, we therefore cut out a Vee in the flanges with the cutting torch. The first or straight bend is made with the rolls, then the short bends are made causing the flange to close up where it had been cut out and then it is welded either by the electric arc or oxy-acetylene process making a very substantial and economical job. This is shown in Fig. 1.

In the tube shop every day hundreds of various sizes and lengths of boiler tubes are repaired. Autogenous welding makes it possible to reclaim many tubes which otherwise, on account of the deep pitting, it would be necessary to scrap. These are reclaimed by filling in these pits by welding with either the oxy-acetylene or electric arc; this operation restores them to serviceable condition, making them practically as good as new tubes. A number of tubes reclaimed in this way are shown in Fig. 2. Many of the larger size tubes from 4 in. to 5½ in. diameter that are beyond repair due to excessive pitting are split full length of tube with the oxy-acetylene torch and flattened out. The plate thus obtained from the tube is used for various purposes. Practically all the larger tubes scrapped are reclaimed in this manner.

Oil drums coming in for repairs we often find are badly damaged, caused by coming in contact with heavy bodies resulting in deep dents in the drum. Some of these dents are so deep we find it impossible to straighten them with internal hydraulic pressure. It is therefore necessary to cut off one end of the drum with the oxy-acetylene torch and straighten them by physical effort. After the drum is straightened the end is fitted back to its original position and welded with either the oxy-acetylene or electric process. This makes a strong durable job and the cost is well within the limits of the original price of the drum. One partly and one completely repaired drum are shown in Fig. 3.

In making repairs to metal pilots the cutting torch is employed extensively in separating the structure, for if the rivets are cut off with sledge and chisel, on account of the light material a decided loss would ensue through damage caused in cutting off and backing out rivets. Fig. 4 shows a pilot on which the rivets have been cut off ready to be dismantled and straightened. We also manufacture in this department tanks, foundry ladles, structural shapes, etc. Welding is employed wherever possible instead of riveting and other methods of joining the metal parts. One or more welding outfits are in constant use in this shop.

Boiler work develops an extensive field for both the oxy-acetylene and arc welding processes. When the inside firebox must be removed, instead of cutting it out as we were formerly forced to do with drills, hammers and chisels, the oxy-acetylene process is now employed. The work is performed not only quicker and cheaper but with less hard labor and with more satisfactory results. In fabricating the new firebox to replace the old one removed we find in laying out the sheets that form it, that numerous irregular shapes develop. Formerly the trimming of these sheets was performed under the power punch. They are now cut with the oxy-acetylene torch which reduces the cost and saves considerable time.

The question of whether the welding together of all the sheets in the firebox is better than the riveted process is now under consideration. We have partly welded fireboxes now in service and their performance so far is all that could be expected and we believe that by employing the long flange so that the weld is made between two rows of staybolts, almost perfect results can be obtained. The welding of these seams can be performed with either the oxy-acetylene or electric arc process.

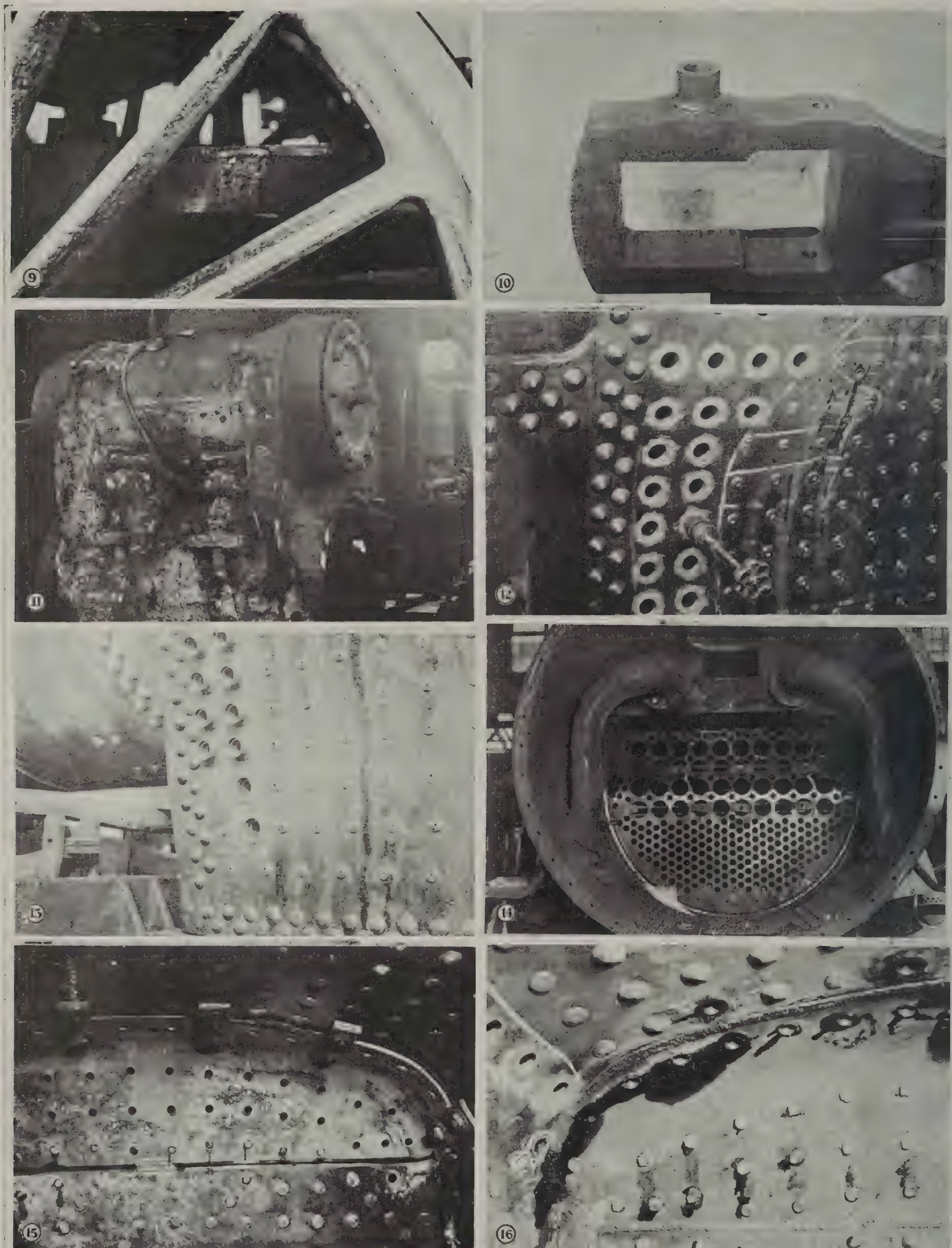
In removing the mudring from the boiler we very often find the bottom of the ring in poor condition due to corrosion. The sharp corner of the mudring in many instances is eaten away. We build up the corners and all flat surfaces where corrosion has taken place. Such a job is shown in Fig. 5.

After the inside firebox is removed from the boiler the staybolts still remain in the outside wrapper sheet. To remove these bolts the oxy-acetylene torch is employed to burn the bolt half way through the sheet; the bolt is then hot enough in the sheet so that it can be worked out by a helper who uses a short length of pipe for this purpose. This method of removing staybolts from side sheets is fast and is an improvement over the old method of drilling them out.

We apply a great many flexible staybolts to locomotive boilers, the sleeves of which were formerly screwed into the outside wrapper sheet, which is rather an expensive operation. The new style sleeve is ball seated and welded to the wrapper sheet by the electric arc process. The oxy-acetylene process could not be employed on this class of work as on account of the diffused heat, the sleeve and sheet would have a tendency to warp. A particularly advantageous feature of the electric arc weld is afforded through the concentration of the intense heat in a small area enabling it to be applied just where it is needed without heating up so much of the adjacent material.

In welding firedoor seams the practice of some roads is to prepare the door hole seam as ordinarily done for plugs or rivets and then lap weld the flange to the back head. The method followed by the Southern Pacific is to butt the flanges of the back head and door sheet, and weld with either the electric arc or oxy-acetylene process. We have been following this process for several years and

*Abstract of a paper presented before the San Francisco section of the American Welding Society, by H. J. McCracken and F. J. Hickey.



Specimens of Welding Work Done in the Southern Pacific Shops at Sacramento

have never experienced any trouble with this method of welding these door holes.

When the bottom of the tube sheet is badly corroded and cracked it can be repaired. If the welding process was not available we would find it necessary to remove the entire sheet, which would cause considerable delay and add greatly to the cost of making repairs to this boiler. The repairs are made by cutting out the lower section of the sheet leaving the dry pipe and header in place and welding in a new section.

Defects that develop in the firebox sheets are repaired with both oxy-acetylene and electric arc processes where new half side or tube sheets are applied. The defective parts are cut out with the oxy-acetylene torch and the electric arc is employed almost exclusively in welding in the sheets.

Another operation in which the electric arc has been employed to great advantage in railroad shops is in the maintenance of boiler tubes. Tubes are applied in the boiler in the usual manner and placed in service. After they have been in service a certain period or when they show signs of leaking the locomotive is held and the tubes are given a thorough working, then the sheets are roughened or sand blasted and the tubes welded to the sheet. We find this method has given excellent results.

There are many other articles repaired in the boiler shop by the electric arc and oxy-acetylene processes. An example is a bail for a dragline bucket. This bail came in the boiler shop broken in several places. We applied a 1 in. reinforcing plate on the bottom side and welded it all around on inside and outside edges with the electric arc process thus insuring a strong durable job which will stand up to the very heavy service imposed upon it.

Machine Shop

Among the many various parts repaired in the machine shop are trailer truck equalizers, transmission bars, eccentric cranks, cross heads, coupler supports, truck frames, draw bar yokes, chafing iron castings, radius bars, truck spring hanger pins, eccentric blades, links, guide yokes, ends of axles, swing hangers for pony trucks, center castings, end sills for tender frames, cylinder head castings, injectors, piston rods, cylinder heads, superheater units, reverse shafts, dope cups on rods, cylinders, piston heads and axle collars.

Foundry

In the steel foundry where many castings are manufactured every day, broken and defective castings can be reclaimed by welding those that are found defective from sand spots, blow holes or shrinkage cracks. These welds when properly made are as readily machined as any other part of the work. Risers and sink heads can be cut off quickly and more cheaply than by any other method.

Fig. 6 shows method of welding high speed steel points on carbon steel lathe tools, which gives very good results and saves making the whole tool out of expensive high speed steel.

Figs. 7 and 8 show a worn outer collar of car axle before and after reclaiming with the electric welding process. By machining the collar to original thickness the axle is ready for use again. It would otherwise have to be scrapped.

Cylinder heads can be built up with the electric method after which the heads are put in a lathe and turned so that they are practically as good as new heads.

A locomotive frame that had broken and was welded with electricity is shown in Fig. 9. This is a very good illustration of the saving that can be made by using the oxy-acetylene or electric welding processes. Formerly with a break of this kind it was necessary to drop the wheels and do considerable stripping before the frame could be welded. This weld was made with the arc without doing any stripping or disturbing the driving wheels. We have had very good success with welds made in this manner. The material is cut out with oxy-acetylene cutting torch, trimmed up by hand and then electric welded; either solid weld or laminated process.

A grease cup welded on a locomotive main rod is shown in Fig. 10. The cup is finished in a turret lathe and set over hole in the rod, welded and then smoothed up with a hollow mill. After finishing they have the appearance of having been made integral with the rod. An electric welding job on a cracked locomotive cylinder is shown in Fig. 11. The break is veed out and studs applied in sides of crack and then filled up solidly with the electric welder.

Photo E-51 shows a patch welded in outside side sheet of a locomotive boiler, also shows new bottom portion of outside wrapper sheet welded at top edge, full length of firebox.

Patches in boilers now welded in place were formerly applied with rivets or plugs and the joints very often interfered with other parts of the machinery. The welded joint overcomes that difficulty, the seams being practically same thickness as the sheet.

Fig. 12 shows the preparation and method of holding sleeves while welding, and Fig. 13 shows flexible staybolt sleeves welded on a locomotive boiler. After holes are drilled and countersunk to suit sleeves the surface surrounding the holes is cleaned and roughened, which breaks away all scale and dirt on sheet and gives the welder a chance to do a much better job than would be possible if roughing was not done.

Both superheater and small flues are electric welded around the beads, which method we have been following in all our shops for some time with very satisfactory results. As all railroad mechanical men know there has been very little if any improvement made in the method of applying and setting flues for the past 30 years or more, and flues will leak, very often causing delay to a train.

Welds across the center of front flue sheet on 2-10-2 class locomotives are shown in Fig. 14, the lower portion of the sheet being new.

A method of applying a patch to the top of a door sheet is shown in Fig. 15. The patch was necessary on account of lap cracks and because the sheet was pitted in the knuckle. This patch as shown has been tack welded in several places in order that bolts and clamps may be removed. The same door sheet after welding is shown in Fig. 16.

Many parts are reclaimed on the reclamation dock with oxy-acetylene welding, such as switch points, frogs, couplers of all sizes and types, coupler knuckles all types, continuous rail joints, track drills, switch stands, oil cups, water strainers, spring plates, steam hose couplings, pipe cutters, monkey and Stillson wrenches, oil drums, ballast forks, body bolsters, truck bolsters, journal boxes, track jacks, brake heads, etc.

The most successful applications of welding undoubtedly have been in places where thorough supervision and

training of welders have been carried on. No matter what kind of material is to be welded, or what the type of welding is, the reliability of the weld rests in a large degree with the operator.

Careful examination and inspection of the welded joint is of the utmost importance. There are certain factors which determine the physical characteristics of the weld. First—examination of the weld by visual means. Second—The edges of the deposited metal should be chipped with a cold chisel or tried with a calking tool to determine the relative adhesion of deposit. Third—Pulling apart welded sections cut from the finished product. Fourth—The bending or breaking test.

Cone Friction Drive for Car Lighting Generators

By A. W. Matthews

The direct drive shown in the illustrations consists of a beveled faced cast iron pulley or disk, bolted to the car axle in the same way as a standard axle pulley, using a corrugated bushing. Two rawhide leather cones engage with this disk, the cones being mounted on two short shafts which project from a gear case. As shown in Fig. 1, ball bearings are used and these should be as large as possible. The two shafts are connected by means of spur gears. One of these short shafts drives the generator by means of a longer shaft, consisting of a telescopic or sliding joint, and two universal joints, as may be seen in Fig. 4. The two sides and top of gear case are removable for inspection.

The friction between the disk and the cones is maintained by means of two adjustable springs, shown in Figs. 2 and 3. The disk and cones are protected from weather conditions by means of a split, sheet-iron cover bolted to the gear case, the gear case and dust cover being suspended from the truck by means of angle iron and strap supports, as shown in Figs. 2, 3 and 4. Ample side play can be allowed for.

Advantages of the Design

(1) The above briefly described drive does not need a special axle. (2) Does not change in any way a standard axle. (3) It is easy to apply. (4) All wearing parts are changeable. (5) There are no bevel gears. (6) Efficient lubrication is provided by means of the gear case which is filled with grease. (7) The friction feature allows slip in the event of the drive becoming overloaded, or in case the wheels skid. The generator may be "motored" by slacking the tension springs.

Thus, I believe this drive includes all of the points that the Committee on Train Lighting Equipment and Practice consider necessary, while I do not think it includes any of the objectionable features, and its construction is so simple that it can be made in almost any small shop. There are of course no hard and fast rules as to the manner of suspending the gear use. There are many ways of doing this, and the same is true of the generator. Fig. 5 shows one way of mounting the generator by placing it in a cradle, spring cushioned and supported from the truck and using just one universal joint.

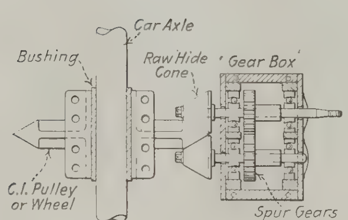


FIG. 1-Section View of Drive

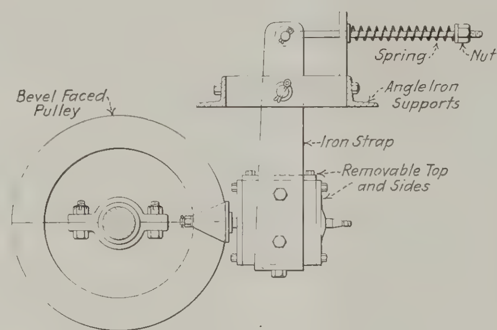


FIG. 2-View Without Dust Cover

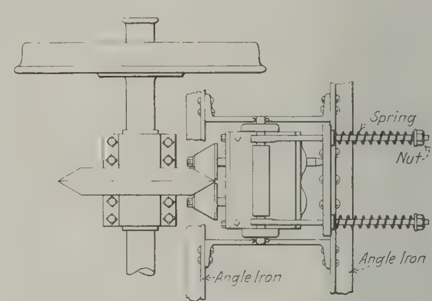


FIG. 3-Plan View of Gear Case Mounting, and Cast Iron Beveled Pulley

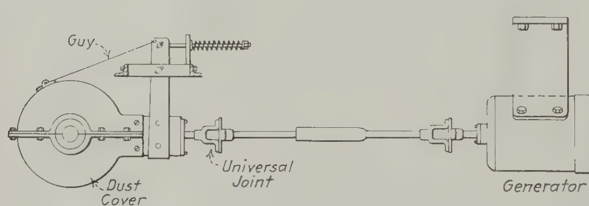


FIG. 4-Application of Drive to Body Suspended Generator

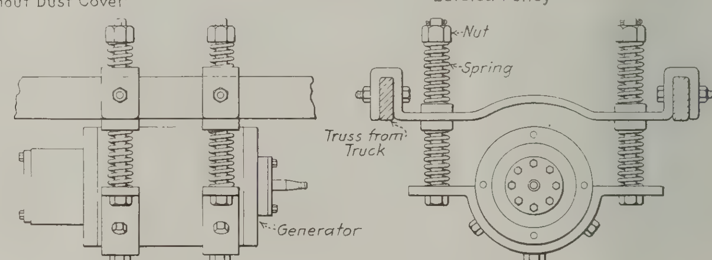


FIG. 5-Truck Suspension

Detail Sketches Showing the Design and Arrangement of the Cone Friction Drive

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Recently the large Amsteg power station of the Swiss Federal Railways was put in operation. This station, in the Canton of Uri, furnishes the electric energy for the Gotthard railway lines, receiving its power from the River Reuss, the Tellibach, the Kärstelenbach and the Etzlibach. It is the largest of the hydro-electric plants of the Federal Railways. Its completion required 800,000 man-days, 180 tons of explosives and 150,000 tons of cement. The station, together with those of Ritom and Göschen—the latter at the entrance of the Gotthard tunnel—will supply the entire electric power for the traffic on the Gotthard line from Basle to Chiasso and in addition supply the energy for the branch lines from Lucerne to Zurich and from Thalwil to Richterswil.

Basic Principles for the Electrical Workman

A Series of Articles Explaining Clearly the Reasons Underlying the Operation of Simple Circuits and Apparatus

By K. C. Graham

Part I—Electricity and Magnetism

ELECTRICITY exists in two forms—as static electricity and current electricity. *Static* electricity is electricity at rest and will not be discussed in this series. *Current* electricity is electricity in motion and it is this phase of electricity that we meet in everyday life. When we speak of electricity throughout this discussion it shall be taken for granted that current electricity is meant.

Now, electricity has never been perceived by any one of man's five senses but its *effects* may be perceived by

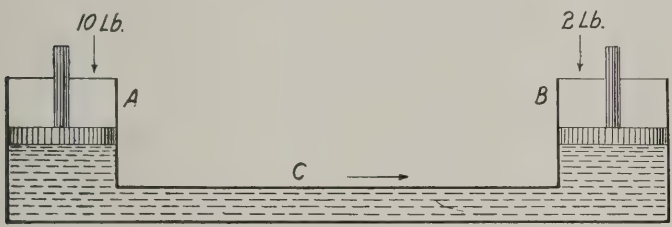


Fig. 1

all of the five senses. It is the effects of a current of electricity in which we are interested and it is by means of these effects that a current makes its presence known. It is also by means of these effects that the current is measured. The two principal effects are the heating effect and the magnetic effect.

A current of electricity may be likened to a current of water; it flows in the form of a current; it cannot flow unless a pressure exists which tends to cause it to flow; it overcomes resistance while in the act of flowing; it flows from the point of higher pressure to a point of lower pressure. This is illustrated in Fig. 1.

Here it is seen that a pressure of 10 lb. on piston at *A* causes a current of water to flow through the pipe *C* to the

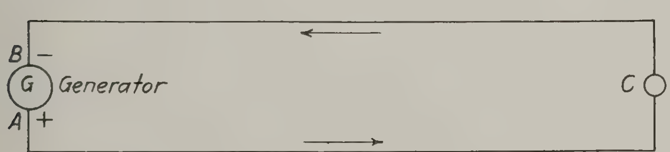


Fig. 2

container *B* where it overcomes the weight or pressure of piston at *B*, which is 2 lb., and raises it in container *B*. *A* is the point of higher pressure and *B* the point of lower pressure. Since the pressure at *A* is 10 lb. and at *B*, 2 lb., the pressure available for raising a weight placed on *B* is the difference between 10 lb. and 2 lb. or 8 lb. Not all of the 8-lb. pressure will exist at container *B* because part of the pressure is lost in overcoming the resistance of pipe *C*.

This same state of affairs exists in the case of an electric current and may be illustrated as in Fig. 2. Here, as in Fig. 1, the current flows from the point of higher pressure *A* through the resistance of wires and lamp *C* to the point of lower pressure *B*. With electricity the point of higher pressure is called positive (+) and the point of lower pressure is called negative (—). Thus we may say that an electric current always flows from positive to negative instead of saying from the point of higher pressure to the point of lower pressure.

Electricity is generated in dynamos or batteries. Although both may really be considered as generators (of electricity) the dynamo is usually meant when we use the word "generator." As the battery is the most simple form of apparatus for generating electricity we shall consider it before taking up the study of the dynamo.

There are two kinds of batteries—primary and secondary. The primary battery generates electricity by chemical means; the secondary battery stores energy by chemical action and is called a storage battery.

A form of primary battery is shown in Fig. 3. It consists of a glass or earthenware jar containing a piece of copper and a piece of zinc partially immersed in a

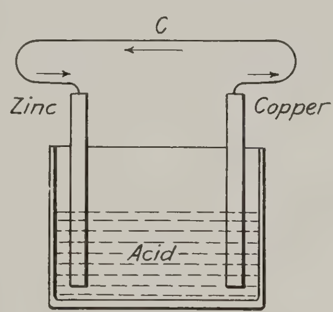


Fig. 3

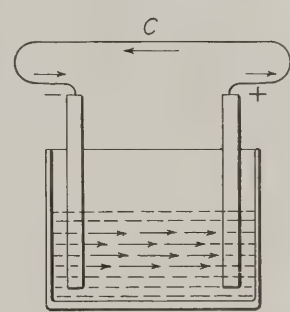


Fig. 4

solution of sulphuric acid and water. When the two pieces of metal, or plates as they are called, are joined by a piece of wire, *C*, a current flows from copper to zinc through the wire. It is well to note the fact that the plates must be two dissimilar metals, that is, if we have two plates of the same material such as zinc and zinc, or copper and copper, no current will flow through wire *C*. This is due to the fact that different metals seems to develop certain pressures when used as plates in a primary cell. For instance, zinc develops a certain pressure which we shall call three. Iron develops a pressure which we shall call two. Now if we put zinc and iron plates into the solution, current will flow from *zinc* to *iron* in the solution and from iron to zinc through wire *C* as in Fig. 4.

At this point it should be noted, and kept constantly in mind, that an electric current always travels over an endless path. This is easily seen by referring to Fig. 4, where it is shown that the current travels from the cop-

per through wire *C* to the zinc and from the zinc to the copper through the solution thus completing the endless path. If at any time the path be broken, the current immediately ceases to flow. The path of the current is called a *circuit*.

A storage battery is very similar to a primary battery. Although the two plates are the same metal they take on quite different characteristics when the battery is in a state of charge. The storage battery will be explained, in detail, later on.

An electric current will only flow through certain kinds of material—other materials prohibit, or refuse to allow

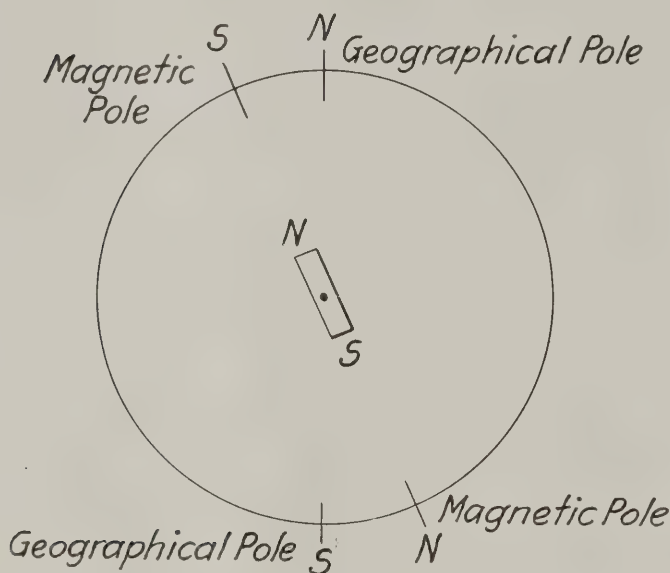


Fig. 5

the flow of electricity through them. The first class of materials is called conductors because they conduct, or allow the flow of electricity.

The second class is called insulators because they obstruct any tendency of the current to form a path through them.

Some conductors are: Silver, copper, iron, nickel, lead, mercury, etc.

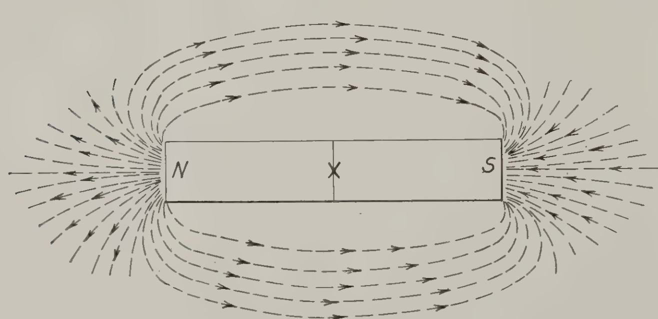


Fig. 6

Some insulators are: Wool, silk, rubber, cotton, glass, etc.

Magnetism

The word magnet was applied, by the ancients, to certain pieces of ore which had the property of attracting pieces of iron to them.

It was also found that if a piece of this ore were suspended by a thread it would turn so that one end would always face to the north and the other to the south, that is, if the piece of ore was turned around so that the end which faced north faced south, it would then turn itself so that the end which originally faced north again faces north.

The end which faced toward the north was called the north seeking end or simply north end of the magnet while the end which faced south was the south seeking or south end. Instead of calling them north end and south end, we now call them north pole and south pole.

It was further noted that if two north poles be brought toward each other they would tend to repel or push each other away and, in the same way, if the south poles of two magnets be brought toward each other they repel, but if a north pole and a south pole be brought together they attract, or pull towards each other. Thus it may be said that *like* poles *repel* and *unlike* poles *attract*.

The earth is a gigantic magnet having a south magnetic pole near the north geographical pole and a north magnetic pole near the south geographical pole. This fact,

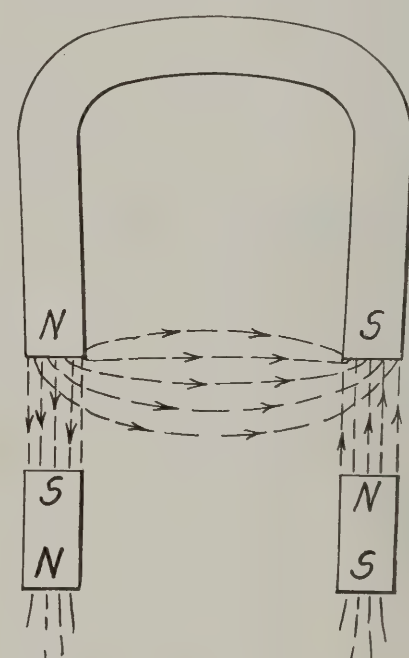


Fig. 7

which may be readily seen by referring to Fig. 5 should be thoroughly understood.

In Fig. 5 it is seen that the magnet which is suspended so as to be free to move, turns so that its north pole faces the south magnetic pole (north geographical pole) and its south pole faces the north magnetic pole (south geographical pole)—this being due to the fact that unlike poles attract. The compass works on this principle, in fact the magnet in Fig. 5 is a compass.

The invisible force which causes magnets to attract or repel is called magnetism. This force exists in the space around a magnet in the form of *lines of force* as shown in Fig. 6.

Here it is seen that the lines leave the north pole and re-enter the south pole. It is also seen that the lines are more crowded at the poles than along the sides of the magnet. Therefore, the magnet is stronger at the poles—in fact at the point *X* there is no "pull" whatever, and this is called the neutral point of the magnet.

Fig. 6 is a *bar* magnet and Fig. 7, a *horseshoe* magnet, so-called because its shape somewhat resembles that of a horseshoe.

If an unmagnetized piece of iron be presented to (brought near) either pole of a magnet as in Fig. 7, the pole of the magnet induces, or causes to form, a pole of opposite polarity in the end of the iron nearest to the poles of the magnet. For instance, pole N of the horseshoe magnet induces a S pole in the near end of one of the pieces, and pole S induces an N pole in the near end of the other. The unlike poles thus formed attract each other thereby explaining why a magnet attracts a piece of non-magnetized iron or other magnetic substance.

Although all magnets are made of iron or steel, a few other metals, such as nickel and cobalt, are magnetic, that is, they can be magnetized or put in such a state that they have north and south poles.

Copper, zinc, and brass cannot be magnetized in the least and therefore iron and steel are said to be magnetic while copper, zinc, etc., are said to be non-magnetic.

Magnets made of hard steel retain their magnetism for a long time and are called permanent magnets. Magnets made of soft iron or mild steel only retain their magnetism for a short time and are merely temporary magnets.

Electric Locomotives Shipped to Japan

Shipment has been made from the Erie Works of the General Electric Company of two 66-ton 1,500-volt direct current locomotives ordered sometime ago by the Imperial Government Railways of Japan. These locomotives include all of the latest improvements in high voltage direct current design and will be tried out by the Japanese Government pending the selection of additional equipment for the electrification of their main line railroads.

The initial operating tests will be made upon the Tokio-Yokohama line, which was electrified in 1915, using motor car equipment manufactured by the General Electric Company. This line operates at 1,200 volts direct current, but it is the policy of the Government in all future electrification work to install equipment for 1,500-volts direct current.

Before leaving the Erie Works, these locomotives were subjected to exhaustive tests to insure compliance with rigid specifications. These tests were witnessed by representatives of the Japanese Government.

The locomotives are of the box cab type, each equipped with 4-GE-274-750/1,500-volt motors geared to a maximum speed of 40 miles per hour. The total weight of the locomotive is 132,000 lb. all on driving axles and it is capable of exerting a tractive effort on the 1 hour rating of 17,700 lb. The continuous rating gives a tractive effort of 17,400 lb. 22 m.p.h. with 1,500 volts on the trolley, In addition to the 1,500-volt rating the locomotive can be operated at 1,200 volts at a somewhat reduced capacity. Further provision is made for operation at 600-volts direct current by throwing a commutating switch, which provides for operating all four motors in parallel instead of two permanently in series, as is the case with 1,500-volt trolley. Protective devices are supplied to prevent damage due to accidental contact with the 1,500-volt trolley when the commutating switch is thrown to the 600-volt connection. The table which immediately follows gives information concerning the physical dimensions and weight of these new electric locomotves.

Weights and Dimensions

Total weight	132,000 lbs.
Weight per axle	33,000 lbs.
Length over all	37 ft. 2 in.
Length of wheel base	26 ft. 0 in.
Rigid wheel base	8 ft. 6 in.
Height over pantograph (locked down)	12 ft. 10 in.
Diameter of wheels	42 in.
Gauge of track	42 in.

The GE-274 motors were designed especially for this locomotive and are the largest so far constructed for a 42 inch gauge truck. Each motor rates 260 hp. on 750 volts and is insulated for operating two in series on 1500 volts. The motors are arranged for ventilation by means of external blowers.

One of the most interesting features of the equipment is the new electro-pneumatic type of control known as type PCL. Two master controllers, one in each operating cab, energize the magnet valves of the pneumatically operated contactors, which open and close the main motor circuits. These contactors are closed by air pressure and opened by a heavy spring acting against the pistons. Ten control steps are provided with four motors in series and eight steps with the motors in series parallel.

A 1500-Volt Locomotive for Japan

Another important feature of this equipment is the high speed circuit breaker, which is connected between the trolley and the main part of the locomotive equipment. Under normal operating conditions this circuit breaker is closed automatically on the first point of the master controller; it then remains closed unless tripped by an overload or short circuit or by momentary loss of the control circuit voltage. After being tripped for any reason the breaker is again reset upon the first point of the master controller. Under normal operation, however, the high speed circuit breaker does not open with the return of the controller to the off position. On account of the high speed of operation of this device, the damage due to short circuits and overloads is greatly reduced and, furthermore, protection is afforded to substation equipment, due to the reduction in the number of abnormal demands due to grounds or overloads. This circuit breaker has no mechanical latches or triggers, but is tripped electromagnetically. It is, therefore, capable of operating for indefinite periods without injury to the moving parts and without changing the accuracy of its calibration.

To protect the locomotive motors against damage due to overload, an overload relay is provided, which is so

connected that in case the motor current exceeds a certain predetermined value the relay contacts open the holding circuit of the high speed circuit breaker which then opens and thus relieves the overload.

For collecting 1,500-volt current, two slider pantograph trolleys are provided having a range of 7 feet from minimum to maximum height. These pantographs are raised by admitting air to a set of cylinders and are held against the wire by springs, which are in turn held under tension by the compressed air in the cylinders. The pantographs are thus lowered by simply releasing the air from the cylinders. The contact elements consist of copper wearing strips which can be easily renewed. A hand pump is provided to obtain compressed air for raising the trolleys for initial operation when there is no air pressure on the locomotive. Normal operation requires only one collector, the other being held as a spare.

The control current is provided by a dynamotor arranged to supply 750 volts for the low voltage control circuits and lights. In conjunction with this dynamotor there are two air compressors designed for 750-volt operation, but insulated for connection, two 1,500-volt circuit. The middle point of the air compressor circuit is connected to the mid-voltage point of the dynamotor to insure equal division of the load between the two compressors. The two blower motors, which provide for ventilating the traction motors, are designed for 750 volts each and are insulated for connection in a similar manner to the compressor motors.

The engineer's cab is also of interest since the master controller is located on the left side of the cab to conform to the practice in Japan of running to the left instead of the right. The usual instruments are provided in this cab, including indicating ammeter, voltmeter, and in addition, an integrating wattmeter for the measurement of power consumed. The master controller is arranged for operation by the engineer with his right hand instead of the left as is the practice with righthand drive.

Shipment of these locomotives was made by water from New York via the Panama Canal.

On the Japanese Government Railways

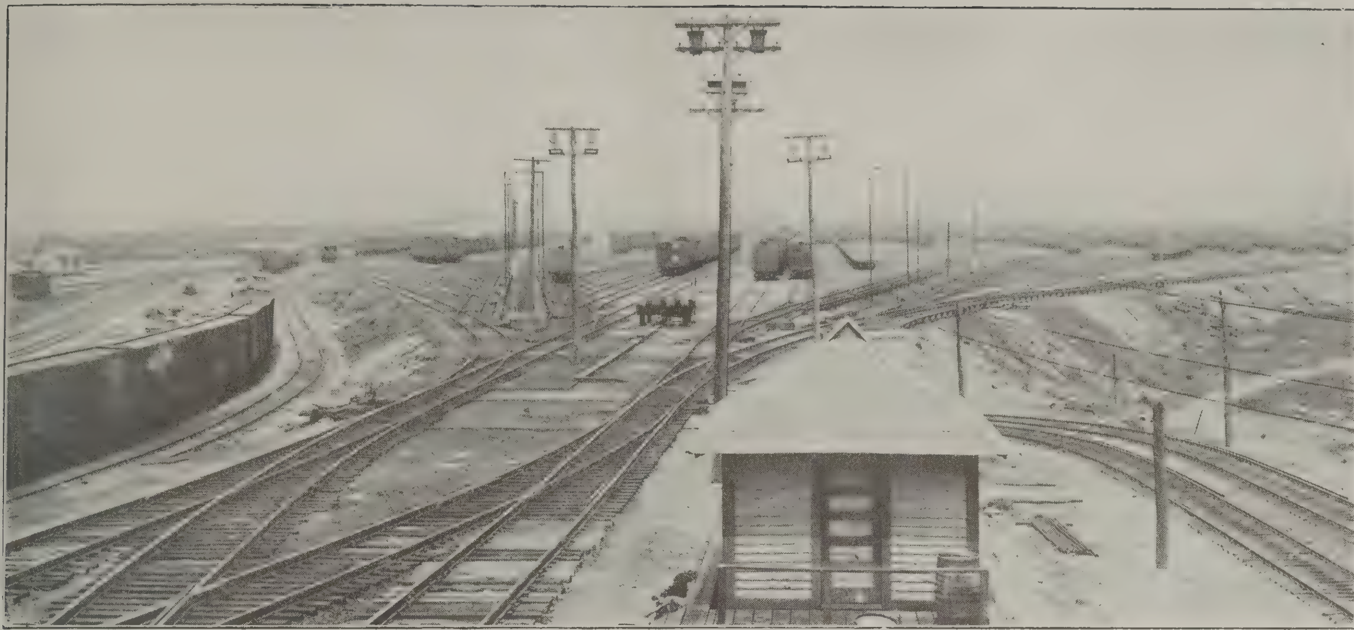
The Electro-Steam Boiler

A recent paper, presented by Sir Vincent Raven before the Institution of Mechanical Engineers in England, describes an electrically heated steam boiler designed by C. Orme Bastian, for the heating of trains on the electrified section of the North Eastern Railway, England. The problem to be solved arose in connection with the heating of rolling stock which passes from ordinary steam track over an electrified section. In the United States, this problem is usually solved with the use of an oil-fired boiler to provide the necessary steam. The equipment designed by Mr. Bastian has been entirely successful and it would not be surprising to find some similar method of train heating eventually substituted for the oil-fired boilers in this country.

The electric boiler installed on the new North Eastern locomotive is 3 ft. 4 in. in diameter and 3 ft. 4 in. long; it is capable of supplying enough steam for the largest train handled in ordinary service. The total loading is 408 kw., but usually this is not required. Heat regulation is secured by grouping the elements in four sets, which permits of six stages, from 68 kw. to 408. Tests made at three-quarters load, with an input of 298 kw. hrs. showed an evaporation of 970 lb. of water at 120 lb. pressure; this pressure was reached in 24 min. after first switching on with feed water at 41 deg. Fahrenheit. Current is taken at the full line pressure of 1,500 volts, and extended trials indicate an efficiency of 98 per cent.

The construction of the boiler is extremely simple, being of the ordinary multi-tubular type, without any of the usual accessories. There are 144 tubes, into each of which is introduced a quartz tube, ¾ in. in diameter; and inside of each tube is a close spiral heating element of resistance wire. Wound in this way the wire is free from the risk of developing hot spots, something which must be carefully guarded against under the special conditions. So satisfactory is the design claimed to be that the firm of Bastian and Allen is willing to build electric moilers even on direct current lines up to 3,000 volts. Simple but adequate means are taken to ensure satisfactory connection with the elements and to prevent damage to the quartz tube by vibration. The tube is mounted on to a mica washer in the end of a hollow porcelain terminal, which is held by spring pressure to the terminal plate of the boiler. The end of the element is silver soldered to the terminal, which is brought in through the porcelain. As extended trials have been made under service conditions with a 50 hp. boiler, the design may be regarded as having been thoroughly tried out. The rating of the boiler is approximately 547 hp. Its compactness, convenience, perfection of control, efficiency, and other qualities should recommend it for adoption in other directions. There are cases where steam has to be applied at points remote from any point where a fuel-fired boiler cannot be conveniently or safely placed. Under conditions in which the electrically fired boiler can be placed where it is needed, thereby eliminating all pipe losses, it may prove the most economical as well as the handiest solution. The electric boiler has proved satisfactory under conditions of vibration and shock.

The man who does his job well does not need to be afraid of his boss. His boss will be afraid he will quit.



Looking from the Hump towards the East Bound Classification Yard at Cedar Hill

Terminal Lighting Development on the New Haven*

Improved Illumination at Cedar Hill and Other Points the Result of Much Study and Experiment

By Geo. F. Johnson

Electrical Supervisor, N. Y., N. H. & H. R. R.

YARD lighting is primarily space lighting, with the following problems injected, namely, the presence of deteriorating gases, movable cars causing shadows, lack of clearance between tracks to place poles, the prevention of glare or light, that will interfere with the operation of trains through or near the yards, and in several of our cases the overhead propulsion current wires.

Historical Development

A short history of railroad yard lighting on the New York, New Haven & Hartford Railroad is necessary in order to understand our reasons for some of the unconventional installations.

Previous to 1912 the yards were small and the illumination was obtained from series or multiple arc lamps, placed about the roundhouses, coal pockets, and wherever space permitted, being local rather than general. The illumination was good because it was necessary to have trimmers who looked over these lamps every two or three days, but it was expensive from the current consumption and maintenance point of view.

Cluster lighting with carbon filament lamps was tried, but was not considered a success.

The larger wattage tungsten lamps, when they finally reached the stage where vibration would not disrupt the filament, were tried, and found to give excellent results, with much less current consumption than the arcs, but the first reflectors tried were not suitable for outdoor use, and after the first wind storm were blown from the fixtures. The manufacturers soon gave us a good rugged porcelain enameled shade for the large size lamps, and we are still using these today, with only one objection, and that is the deterioration caused by locomotive gases and the consequent loss of illumination after a short exposure. Larger yards were being built, but no consideration was given to illuminating the whole yard. The localized lighting still being the style.

In 1913 estimates and plans were prepared for Maybrook, N. Y. The plans called for an expensive system of overhead supporting wires in the classification yard, so as to permit the spotting of lamps to cover the whole area of the yard. The estimated cost was about $20,000, and the maintenance for the overhead structure would have been excessive. This was filed for future consideration and a time when the authorities might have the cash and no other use for it.

Shortly after our attention was called to a so-called "flood" light, a type of lamp using a standard 1,000-watt lamp and a silvered glass reflector that would spread the rays in such a way as to prevent glare and give a good soft light. The illumination was effective for a distance of about 500 feet for a single lamp and the spread approximately 40 feet per 100 ft., while the appearance of the lamp was similar to that of the oil headlights used on the locomotives. A few of these were obtained and installed with excellent results at construction jobs that were being carried on through the 24 hours of the day.

Other types of projectors or searchlights using the concentrated filament lamps were also tested, but while they were effective a greater distance, the spread of the beam of light was much less and the light blinding.

* A paper presented on January 9, 1923, before the Society of Terminal Engineers at New York City.

Our opportunity of demonstrating the cheapness and effectiveness of this type of lighting came with the starting of the European war and the demand of the military guard, protecting our bridges, for the illumination of the structures.

The operating officials at Poughkeepsie obtained an estimate of $7,000 for lighting the bridge as requested by the militia. When called into the conference, we proposed the use of flood lights, two on each side of the river, and on opposite sides of the bridge. Structures about 30 feet above the water were used on the east side and on the west side advantage was taken of the high ground above the West Shore tracks and no structure built. The military officials were skeptical, fearing that the rays would be blinding, but a test proved otherwise and objections were withdrawn.

The cost of this installation was $1,500 and the success obtained from it caused us to standardize on this type for other bridges where the distance was over 600 feet, the width of the Hudson at Poughkeepsie being about 2,000 feet. When shorter distances were to be illuminated an open angular type of shade was used, this being similar to those you now see on bill-boards on the outskirts of the cities.

Shortly after this, owing to the increase in freight business, it became absolutely necessary to work both east and west bound humps at Maybrook twenty-four hours a day, at full speed, and lighting was necessary. It was impossible to obtain sufficient 1,000-watt flood lights within a reasonable time, but we could obtain projectors or search lights, a type that we considered too radical to use in or about railroad yards. This call came in January and

Looking Toward East Bound Receiving Yard at Cedar Hill. Note Angular Reflectors on Pole Line on the Left

the time allowed for completion of the work was short. As the current of traffic on the humps is in one direction it was decided to install the 400 watt projectors. These lamps were placed 250 feet apart. A 1,500 foot pole line was built along the ladder track. Seven lamps were installed on each hump, and no complaints have been received to date. We took advantage of all high buildings about the yard, such as ice house, office building, coal pocket, tanks and machine shops, and installed the few 1,000-watt flood lamps which he had. This work was completed within two weeks by our own maintenance forces, and cost $4,000, and covered practically twice the area mentioned previously, and we believe just as effectively.

The Lighting at Cedar Hill

The Cedar Hill yard we will separate into two classes. The first, that part which was placed in operation the latter part of 1912, and consisting of the power plant, machine shop, roundhouses, storehouse, office building, ash pit and coal pocket, and the second part, placed in operation in 1918, consisting of the eastbound receiving yard, the eastbound hump and its buildings, the eastbound classi-

Cemetery Street Bridge, Providence. Lighting Units are Supported From This Bridge

fication yard with its mill building, the transfer platforms, and the office building. The westbound facilities being similar to the east will not be considered.

The lighting of the first part was originally arcs and passed through the various phases until 1,000-watt flood lights were installed on the coal pocket, water tank, foot bridge and catenary columns, this yard being electrified with overhead wires at 11,000 volts. The coal pocket is lighted with 25 and 50 watt lamps in shallow bowl porcelain enameled reflectors. The round-houses are lighted with two 50 watt headlights, 6 ft. above the floor on the rear wall between each pit, and on each post are placed goosenecks with 25 watt shallow bowl porcelain enameled reflectors, 10 ft. 6 in. above the floor, and on two of the posts are placed receptacles for extension lamps. This house was originally planned for arcs and the saving per year, with current costing three cents per kw. hr., is approximately $3,500. The wattage per square foot of floor surface is 0.1, which is an extremely low figure. The cost of our later installations of this type is also cut about 66 per cent on account of the load being reduced 75 per cent. This installation was one of the first of this type, if not the first, in the United States.

The machine shop is general illumination with local lighting about the machines. The general illumination being sufficient to take care of rough work.

The power plant consists of two 185 kw. engine driven generators, 3 phase, 60 cycles, 440 volts. This voltage having been selected before the new yard was considered.

At the present time we are boosting this voltage to 2,300 volts to run to the new yard for power and lighting. The control of our flood lighting, in new yards, is through the switch-board in the power plant so that current will not be wasted.

On account of the overhead propulsion wires, it was necessary to run underground about 2,500 feet and creosoted wooden duct is used and has proven very satisfactory.

The eastbound receiving yard is electrified, and covers a space approximately 5,600 feet by 200 feet wide. We have taken advantage of the columns supporting the electrified wires and every 600 feet have placed two 1,000-watt flood lamps on platforms, or a total of eighteen lamps.

At the hump the open type of angular shades are used to flood this space, and these fixtures are placed every 100 feet and about 20 feet from the track. The eastbound classification yard has two double ladders, and we have placed two projectors on each pole, but otherwise the installation is similar to Maybrook.

The West Bound Hump at Maybrook Showing Lighting Units on Pole Line at the Left

The transfer platforms are 1,200 feet long by 30 feet wide and are lighted by two lines of 25 watt lamps spaced 20 feet apart, and about 5 feet from edge of platform. Three of these platforms are built, and the service is carried to center of platforms, and lights are turned off and on by contactors controlled by switches in the office building, situated about 100 feet east of the platform. This places the control of lamps under some responsible head, and results in current economy, and cuts maintenance. At this point electric tractors are used that consume 15,000 kw. hr. per month and as this charging is done during the night hours or at a time when our demand is lightest, the result is a very low cost for current.

Recently we have installed coal pockets at East Hartford and Providence, and advantage has been taken to install flood lights 70 feet above ground at a very low installation cost.

In concluding we firmly believe that while flood lamps are not a "cure all," they have resulted in a large increase of efficiency and decrease in accidents and at a minimum of expense. This result would have been long delayed with the older type of lighting, owing to its greater cost.

Speaking of enemies, don't have them. Don't fight. Don't get even; ignore. Life is too short for grudges and vengeance. Go on. Let the other fellow stew. You keep sweet. Nothing can punish him worse. If a man doesn't like you, keep away from him. It's a large, roomy world. And, thank God, there's always another side to the street.

Westinghouse Develops New Transformer Invention

Sargent & Lundy, consulting engineers, of Chicago, representing the Middle West Power Co., have purchased from the Westinghouse Elec. & Mfg. Co., a 25,000 kva. bank of power transformers which incorporate an entirely new principle in transformer design, claimed to eliminate any possibility of the explosions which sometimes occur in large transformers. These transformers are to be installed in the Grand Tower Illinois Station of the Middle West Power Co.

Many months have been spent in the study of the problem of improving existing designs and this study has finally led to several new and important inventions. Large quantities of insulating oil are used in power transformers. While this oil is specially prepared for the purpose and ordinarily represents a very small fire and explosion risk, it sometimes happens that peculiar combinations of circumstances bring about rather serious explosions with transformers as heretofore constructed.

This new principle consists of filling the transformer case above the oil level with nitrogen, which is a harmless and inert gas that is incapable of forming an explosive mixture with oil vapors arising from the oil. The nitrogen gas used is generated in an ingenious device of simple design which is attached directly to the transformer tank. This generator works automatically to keep the space above the oil level always full of the protective nitrogen. No oxygen, which is the element needed to produce explosions or start a fire, can enter or be present in the tank. The protective layer of inert gas above the oil level acts as a cushion or buffer to take the shock off any sudden pressures that develop under the oil level if there should be a short circuit or any defect in the transformer windings. An electric arc under the oil level, if it should occur, can produce a tremendously quick pressure in a tank. The sudden impact of this pressure against the walls and cover of a transformer tank which is completely full of oil, has been known to burst the tank and cause a serious interruption of service to electric power and light users. The cushion of nitrogen gas is easily compressed and it is enough of a buffer to take the brunt of the explosive pressure and save the tank from injury. The oil in the transformer represents quite an investment. In ordinary designs of power transformers it may deteriorate and lose some of its effectiveness in insulating the transformer and keeping the windings cool. Most of this deterioration comes about through contact with air or moisture. This inert gas principle protects the oil against both air and moisture and claims are made that the oil with the new principle will improve with age. This new development, it is believed, is a great advance in transformer design and it will in all probability solve successfully the problem that has hampered the furthering of high voltage projects all over the country. The transformers for this Illinois installation will be the first of this type to be built.

If you insist on a loose rein, you've got to take the responsibility of keeping the wagon on the road. That's horse sense.

The spirit of adventure is so strong in some people that as soon as their jobs pass the teething stage they lose interest and want to start on something else.

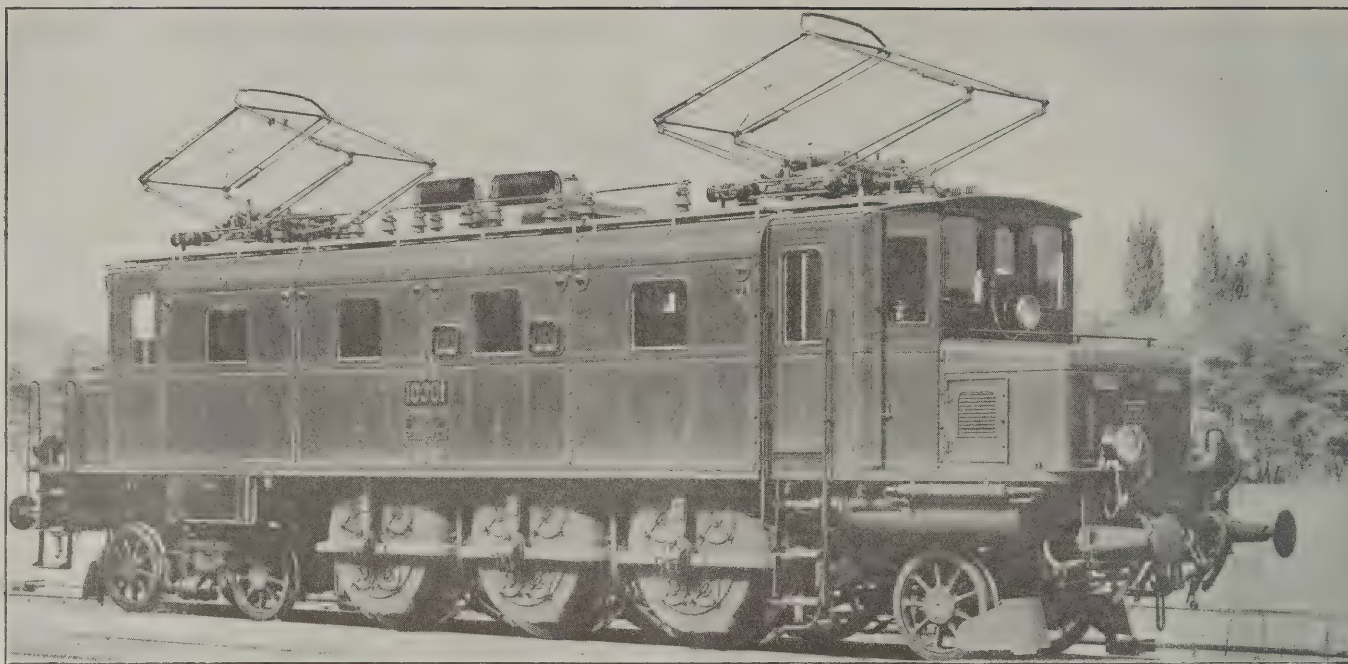


Fig. 1—Left or Geared Side of One of the 4-6-2 Locomotives Now in Service Between Berne and Thun on the St. Gothard Line, Switzerland

Unique Type of Drive for Electric Locomotives

Device Permits Use of Long Motors With a Minimum of Non-Spring-Borne Weight

A MECHANICAL connection between the motors and driving wheels of an electric locomotive, known as the Brown Boveri Individual Axle Drive has been developed by Brown Boveri & Co., Baden, Switzerland. Eight locomotives equipped with this drive have now been in service for nearly a year on the St. Gothard line of the Swiss Federal Railways with apparently satisfactory results. One of the locomotives is shown in Fig. 1 and details of the drive are shown in Figs. 2 and 3. The locomotives have a 4-6-2 wheel arrangement and have one-hour and continuous ratings of 2,100 hp. and 1,700 hp. respectively. They will develop a maximum tractive effort of 30,000 lb. and a continuous tractive effort of 15,000 lb. The driving wheels are 63½ in. in diameter and the total weight of the locomotive is 91.5 metric tons or approximately 200,000 lb.

Prior to its use on the St. Gothard line the Brown Boveri individual drive was tried out experimentally on the Lötchsberg Railway for over three years where it gave very satisfactory results. The only change that was made to the drive as applied to the new locomotive was that it was made somewhat heavier, a spring hub for the pinion was added and also a mechanical lubricator for the drive.

The upper half of the gear casing shown in Fig. 1 is very heavy, is mounted rigidly on the frame and supports the pin on which the gear rotates. The motor, motor pinion and gear are all centered rigidly on the locomotive frame. The pinion has a spring hub; the coil springs, Figs. 2 and 3, provide a cushioning effect in rotation but do not permit the periphery of the pinion to change its distance from the center of the motor shaft.

The top half of the gear case, which is bolted to the main frames is so constructed as to carry a third bearing for the motor rotor shaft on the outside of the pinion, in addition to the pin upon which the gear wheel turns freely. In order to obtain a satisfactory gear ratio (1 :2.57) the gear wheel is set somewhat higher than the driving wheel centers, the actual difference being about 1 in.

The torque from the gear is transmitted to the driving wheel by a coupling device which is elastic in all directions, consisting of a system of levers mounted on the center part of the gear wheel. There are two pins, A. A., Fig. 2, on the driving wheel to which are attached two rods, B. B., having spherical bearings which allow sufficient freedom of movement between driving and gear wheels. The other ends of these are forked and form knuckle joints at C. C. with the toothed segments S. S., which oscillate about the pins D. D. mounted on the gear center. This arrangement permits of free vertical and lateral displacement of the drivers relative to the frame and it is also possible for them to adapt themselves to a curve, as when, for example, the pony and leading driving wheels are combined in a Helmsholtz truck.

All the gears are carried on one side of the locomotive and to balance this, the auxiliary apparatus has been placed on the opposite side of the cab. This would not be essential in a locomotive having an even number of drivers but has the advantage of permitting a wide passage from end to end of the cab, without curtailing accessibility of either motors or auxiliary apparatus.

The Locomotive

As previously stated, the gearing is on one side of the locomotive only, namely, on the left hand side when the

locomotive is running with the four-wheel guiding truck forward, while the driving wheels on the other side are completely free. The leading part of the locomotive rests

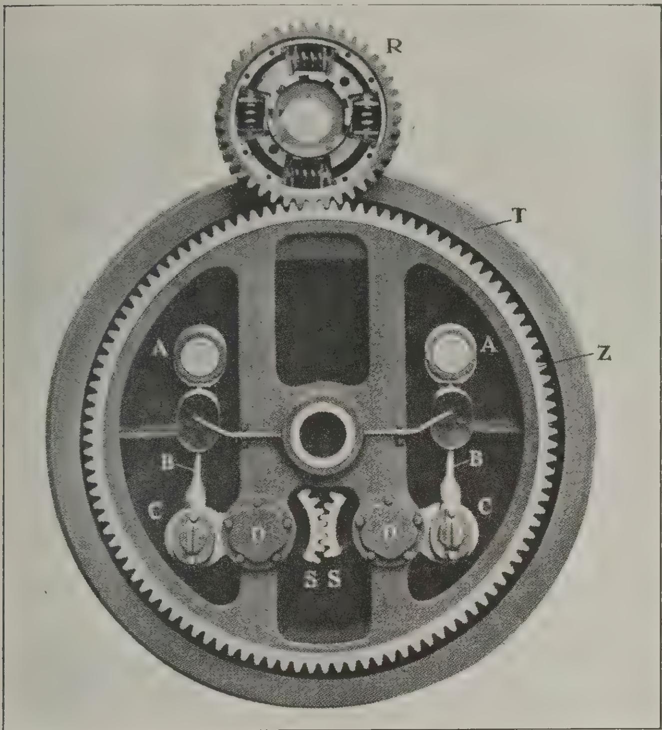


Fig. 2—Pinion, Gear and Driving Wheel as Assembled in the Individual Axle Drive

on a 4-wheel truck and the trailing end on a 2-wheel Bissel truck.

According to the manufacturer, the locomotive runs somewhat more smoothly with the 4-wheel truck leading than when traveling with the Bissel truck first. Only one leading axle is, however, necessary for the prescribed maximum speed of 56 miles an hour. All trucks and driving axles are mounted on a single frame.

The builder also states that a more pleasing appearance would have been obtained if two 4-wheel guiding trucks had been used, but that three driving axles and three guiding axles are sufficient to carry the locomotive with an allowed axle load of 20 tons on driving axles and 15 tons on guiding axles.

Only one transformer is provided in order to keep down the weight. This is another reason why the locomotive is not symmetrical as the transformer is mounted over the 4-wheel truck and its weight constitutes the greater part of the load that is carried by the truck. It was not possible to place the transformer between the main motors on account of the driving wheels. The drive also causes the locomotive to lack symmetry. The trial locomotive used on the Lötchsberg, however, had a symmetrical arrangement of the transmission gearing. The arrangement as used on the Swiss Federal locomotive illustrated has the advantage of being simple and also enables an appreciable saving of weight to be made. This is probably the first application to an electric locomotive of the one sided drive which is common for stationary electric motors.

The design of the locomotive permits high center of gravity of the motor and gives the locomotive body a large moment of inertia with regard to the longitudinal axis. This, it is claimed, insures smooth running at high speed. The term "longitudinal axis," means the axis about which the spring-borne portion of the locomotive can rock; it is approximately at the same height as the carrying spring.

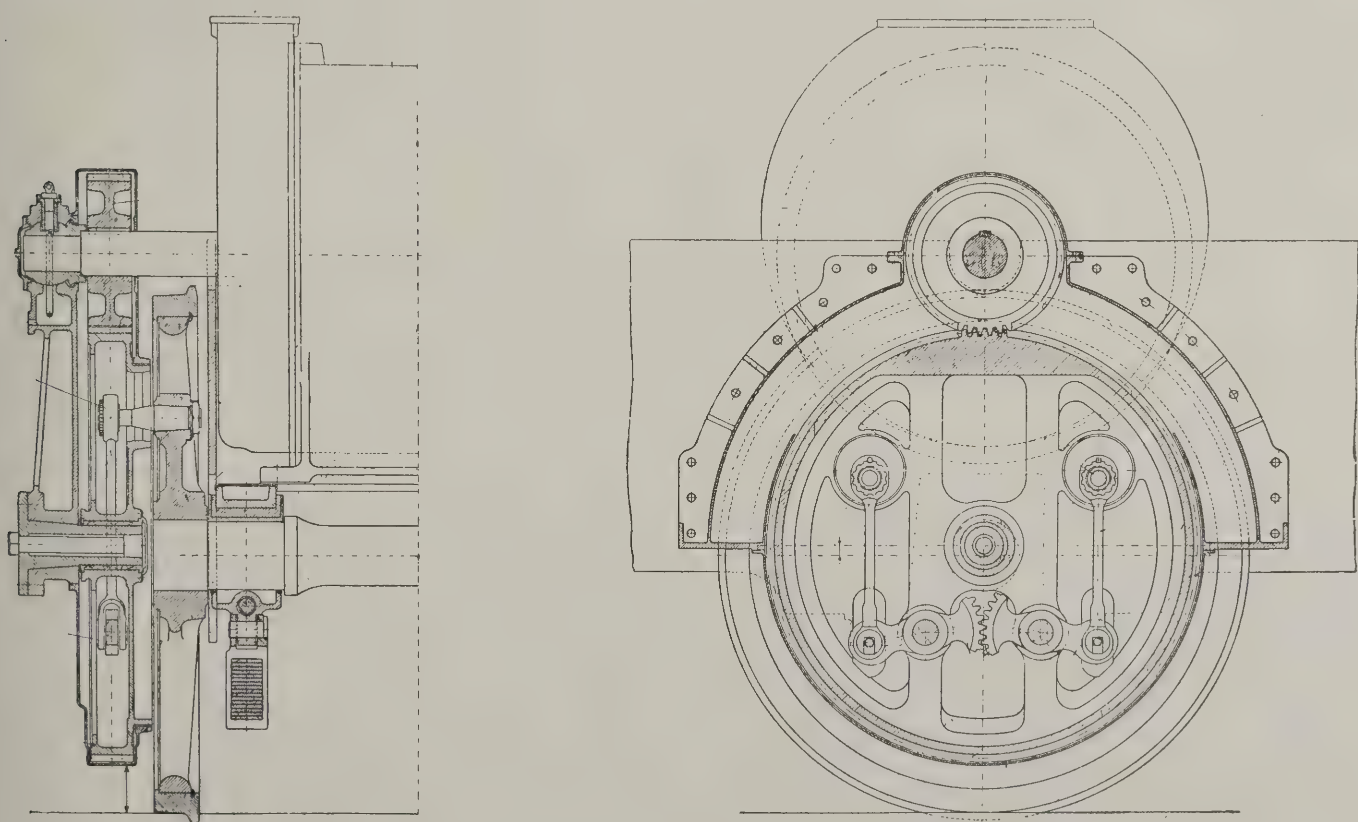


Fig. 3—Section and Side Elevation Showing Details of the Drive

A Train on the New York Westchester and Boston

Electric Traction Developments in 1922

New Equipment Purchased and New Projects Initiated—Greatest Activity Abroad

THE most notable development in electrical traction in the United States during the past year was the decision of the Illinois Central to adopt the 1,500-volt direct current system with overhead trolley for the electrification of the Chicago terminal district. Other activities in this country were confined largely to equipment orders.

The Pennsylvania has announced that it will electrify the heavy grade west of Altoona and that extensive improvements will be made at Altoona, Pa., including the construction of two extremely large repair shops. Announcements has also been made that the Pennsylvania will build three electric locomotives, the electrical equipment for which will be supplied by the Westinghouse Electric & Manufacturing Company. One of these locomotives will operate on 11,000-volt alternating current and the other two will be equipped to operate on 600-volt direct current. During the year the Pennsylvania also decided to purchase power from the Philadelphia Electric Company for the operation of the West Jersey & Seashore Electric Line which runs between Camden and Atlantic City.

The Pennsylvania Railroad Company will soon have in operation 15 new multiple unit cars on the Paoli electrification in Philadelphia, making a total of 130 cars in operation.

The Baltimore & Ohio ordered two 120-ton 600-volt direct current electric locomotives from the General Electric Company. These locomotives are to be delivered in March, 1923.

The New York, New Haven & Hartford ordered 12 180-ton 11,000-volt electric locomotives for passenger service from the Westinghouse Electric & Manufacturing Company. These locomotives will also be equipped to operate on 600-volt direct current into the Grand Central Station, New York. The railroad has also secured eight motor cars and 14 trailers, utilizing series type alternating-current motors and storage battery control. A new 9,000-kw. turbine generator unit will be placed in the Cos Cob power station to take care of the additional load on the electric system.

The New York Central is installing a 1,500-kw. and 500-kw. direct current turbo-generator at its 50th street service plant in New York City at a cost of $122,000. A remote control sub-station is also being installed at 110th street, New York City, at a cost of $265,000. Work on both of these projects is nearly completed.

The Norfolk & Western ordered through Gibbs & Hill, New York, from the American Locomotive Company, four 380-ton, 11,000-volt alternating current electric freight locomotives. The electrical equipment for these locomotives will be supplied by the Westinghouse Company.

Surveys are being made on the Virginian for the purpose of determining the value of electrifying a section of that road.

The Long Island has announced that it will improve and extend its electric service. A 25,000-kw. generator has been installed in the Long Island City power plant and additional feeders have been run in conduit along the right-of-way to Forest Hills. The company has also started the work of extending the elevated structure through Hollis, Long Island, eastward through Queens to the Nassau County boundary line, a distance of about two miles. This extension will be elevated and four-tracked at the same time and the four-track section will be continued to Floral Park, two miles farther east. It is estimated that the work will require about a year and a half for completion at a cost of $2,000,000.

Trackage rights on the Missouri, Kansas & Texas have been negotiated for by the Texas Power & Light Company and the Dallas Power & Light Company for the purpose of supplying electric passenger service between Dallas and Denton, Texas, a distance of 48 miles.

Complete data on heavy electric traction in North and South America was prepared this year by the Committee on Heavy Electric Traction of the Association of Railway Electrical Engineers. This data was present at the annual convention of the Association held in Chicago from October 31 to November 3, inclusive. Similar data covering foreign electrified railroads was compiled by the

Heavy Electric Traction Committee of the American Electric Railway Association and presented at the annual convention of that Association held in Chicago during October.

Electric Traction Development Outside of the United States

The most extensive electrification initiated during the year outside of the United States was that of the South African Government Railways. Locomotives using 3,000-volt direct current will be used and the section electrified will extend from Glencoe to Pietermaritzburg, a total of 174 route miles. The total expenditure involved is placed at about $20,000,000 and was divided up among a number of British firms; namely, the Metropolitan-Vickers Electrical Company, Ltd., T. A. Parsons & Co., Ltd., Babcock & Wilcox, Ltd., British Thomson-Houston Company, Ltd., Telegraph Manufacturing Company, A. Reyrolle & Co., Ltd., and the South African General Electric Company.

Of probably greatest importance to American manufacturers is the Mexican project. The International General Electric Company received an order from the Mexican Railway Company, Ltd. of Mexico City for the electrification of 30 miles of single track between Orizaba and Esperanza. Direct current (3,000 volts) will be used and the initial order for equipment included ten 150-ton locomotives, interchangeable for freight and passenger service.

In Canada the electrification of the Harbor Railway Terminals in Montreal, Quebec, is proceeding and it is expected that the total trackage of 58 miles will be entirely electrified some time during the next year.

Negotiations are in progress for the electrification of a section of the Central of Brazil.

According to commerce reports, 1,500,000 gold pesos is to be provided by a proposed law for the electrification of the Argentine Transandine Railway between Zanjon in the Argentine and the Chilean frontier. The length of the line is about 28 miles.

Work on the electrification of the Chilean State Railways between Valparaiso and Santiago was begun on April 12 and material for this work is being shipped from time to time by the Westinghouse Electric & Manufacturing Company and the Baldwin Locomotive Company.

In England plans and negotiations are being made for the purpose of obtaining a supply of electric power for the electrification of the South Eastern & Chatham. A new type of electric locomotive for high speed passenger service, which has a symmetrical wheel arrangement and unusually large driving wheels, is being tried out on the North Eastern Railways. The London, Brighton & South Coast Railway, England, has deposited a bill in Parliament to raise additional money for the purpose of electrifying certain portions of its line. It is estimated that the work will require an expenditure of between four and five million dollars. The Metropolitan Railway in England has rebuilt 20 locomotives for high speed passenger service.

A concession was granted to A. S. Akersbanerne in Norway for the construction of an electric railway to extend from Christiania to Ostensjo, a distance of about five miles. Two additions have been made to the Riksgränsen Line in Scandinavia during the last year. These additions extended the line from Nattavara to Lulea, a distance of about 100 miles, and from Riksgränsen to Narvik in Norway, a distance of about 25 miles.

The Dutch Government has appointed a commission for the purpose of studying a general electrification plan for Holland, which includes the electrification of the Dutch Railway.

Work has been started in France to electrify the 145 miles of the Paris-Orleans Railway from Paris to Vierzon. The 1,500-volt direct current system will be used. Contracts amounting to $8,000,000 have been let and equipment is being supplied by French, English, Swedish and American companies.

Switzerland has been particularly active in the development of its electrification program. The work of electrifying the St. Gotthard Railroad was finished and the second bore of the Simplon tunnel was completed. This tunnel is over 12 miles in length. A number of new locomotives has been placed in service on the Swiss Federal Railways, including three or four new types.

A contract was let to the General Electric Company in 1921 for the electrification of 40 miles of the Spanish Northern Railway. Completion of this work is in progress and during the year six 3,000-volt direct current locomotives were ordered from the Westinghouse Company.

In Italy, the work of electrifying the Bologna-Florence, Faenza-Bologna, Genoa-Pisa, Rome-Tivoli, and Rome-Anzio-Nettuno Lines is in progress.

The Hungarian government is making efforts to electrify the State railways through the agency of a special government commission.

A large railway electrification program is being placed in effect in Japan; 600-volt and 1,200-volt direct current will be used. During the year the English Electric Company received an order for 34 complete electric locomotives of a total value of over $2,000,000. Two locomotives were also ordered from the General Electric Company in this country, two from the Westinghouse Electric & Manufacturing Company, two from the English Electric Company (England), and two from Brown, Boveri & Co. of Switzerland. The Westinghouse Company also supplied motor car and substation equipment.

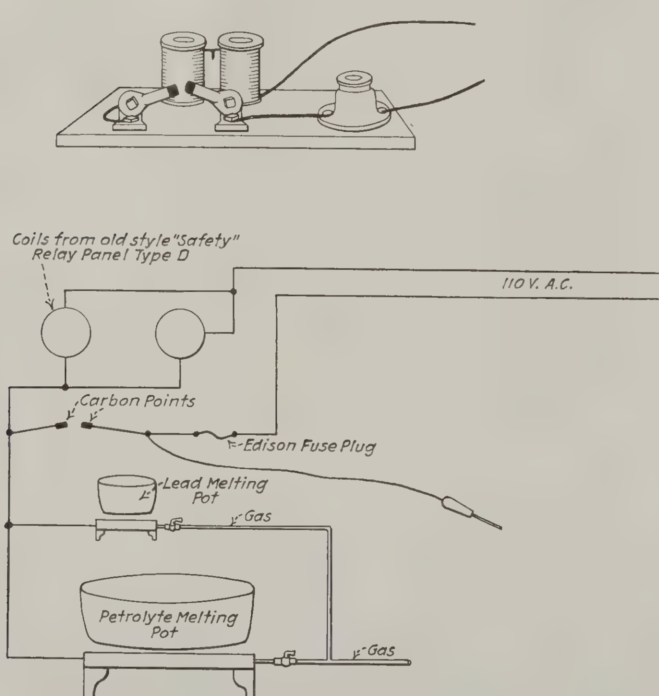
Estimates made in the Netherlands Indian budget for the electrification of the railways of Java have been accepted, but no time has been set for the beginning of the work.

Don't consider yourself more intelligent than the rest because you have different views from them. You might learn something YET.

A Well-Maintained Tangent on the W. & L. E.

Electric Igniter for Lead Burning Torch

A convenient scheme of lighting a lead burning torch or the gas jet underneath a lead melting pot or petrolyte kettle may be easily made from material which is usually found in almost any battery overhauling shop. One device of this nature is shown in the illustration below and it has been found to be a very handy tool by the workmen who make use of it daily. The apparatus consists of two coils, taken from an old style "Safety" relay panel, type D, two wire terminal lugs, two carbon points from a "Gould" automatic switch, two improvised terminals for mounting the lugs, one porcelain lamp socket with external connections and one Edison fuse plug to be used in the lamp socket. This material is assembled on a small board and connected in circuits as shown in the wiring diagram below the illustration of the apparatus.



Sketch of Apparatus and Diagram of Connections

It will be seen that the two coils are connected in parallel with each other but in series with the carbon points and fuse. The apparatus is connected to the ordinary 110-volt alternating current lighting circuit. The carbon points do not touch each other and therefore the device consumes no current except at the instant when it is in use. The space between the carbon points should be from ⅛ to ¼ in.

In using the device, the operator simply turns on the supply of welding gas and uses the nozzle of the torch to close the gap between the carbon points, thus permitting current to flow through the circuit. This contact is only for an instant and as the operator withdraws the metal torch a spark is created by the breaking of the circuit and the gas is ignited.

The usefulness of this apparatus may be readily extended to the lead melting pot or to the petrolyte kettle as both of these are usually heated with the gas flame. To accomplish this, a single wire is connected to one of the terminals, as shown in the drawing, and the end of this wire applied to the jet under the pot or kettle as desired. The spark which instantly follows the withdrawal of the wire will of course ignite the gas in the same way as with the torch. The illustration shows the frame work and gas jet under both of these melting vessels as being connected with one of the terminals of the apparatus and the loose wire connected with the other terminal. Ordinarily, however, the alternating current circuit is grounded on one side and, therefore, it is only necessary to run a single wire through a resistance from the side which is not grounded.

A device of this nature will prove to be exceedingly convenient and do away with the use of matches for these several purposes.

Boring Holes in Close Quarters

A useful addition to the wireman's tool kit is an ordinary iron doorknob. The hole in the shank of a doorknob is of the proper size to hold the square shank of a wood bit and will be found very well adapted for that purpose when drilling holes in close quarters in boxes and cabinets.

How Savings Grow

It is the tendency in some families to live up to the limit of the income. If the income is $30 a week, the expenses are $30. If the income drops to $25, expenses drop likewise. If the income jumps to $40 expenses skyrocket too.

The fact that luxuries and many things unnecessary usually have a part in these expenditures is reason for special consideration of this subject. Is it not better to have a little savings account as a nest-egg than to "blow it"?

Moreover, it is not necessary to save in large amounts,

little drops of water make the mighty ocean; and little dimes and nickels make the mighty fortune.

Few families in ordinary circumstances are unable to lay aside one dollar a week and hardly notice the difference. That one dollar a week in a year will be $52, in two years with usual bank interest it will be over $106; in four years it will be over $220, and in ten years it will be over $615, a tidy sum which will accomplish a great deal and its saving caused little or no hardship.

Had the weekly savings been two dollars instead of one, the result would have been over $1,230, and increased weekly savings would multiply accordingly.

Putting money in the bank every week and keeping it there is a matter of will-power. Say that you will and do it. Begin today. Saving is not a hardship. It is a pleasure.

You will increase your power, success and happiness.

Prefer diligence before idleness, unless you esteem rust before brightness.

The trouble with most of us is that we won't face the facts.

The most unpopular advice one can give is that flavored with common sense.

As a rule the American is proud of his country, his government and his independence. Why should he not take pride in his work?

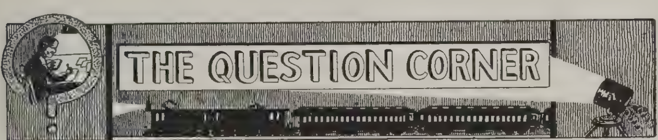
Send It In

If you have a bit of news,
  Send it in;
Or a joke that will amuse,
  Send it in;

A story that is true,
An incident that's new,
We want to hear from you—
  Send it in;

Never mind about the style,
If the news is worth the while
It may help or cause a smile—
  SEND IT IN!

The above verse which was taken from the Santa Fe Magazine so completely expresses the sentiments of the Railway Electrical Engineer that we could not refrain from publishing it here. Of course we are not desirous of being deluged with jokes but short articles descriptive of Railroad experiences, particularly of the type that deals with practical electrical problems will be given utmost consideration.—Ed.



Answers to Questions

1. *Is it possible to operate a 6-volt radio set from a d. c. 110-volt line by reducing the voltage with lamps in series, or by using a resistance?*

2. *Would you be able to let me have the address of the concerns manufacturing the following systems of car lighting and locomotive lighting equipments: Buttner system; Brown, Boveri system; Consolidated systems, Type A and Type D and L Regulators; Dick system; G. E. L. system; Gould Simplex system; Leitner system; Mather and Platt; Newbold system; Pintsch-Grob system; Safety system; Stone system; U. S. L. system.*

Six Volt Tube on 110-Volt Circuit Not Practical

1. The operation of 6-volt vacuum tubes in a radio receiving set from 110-volt line by reducing the voltage with resistance could hardly be considered as practical. Any sudden fluctuation in voltage would, of course, be a distinct hazard to the expensive tube, but what is more to the point such circuits are usually supplied from a generator which would be almost certain to introduce undesirable noises in the telephone receivers. Developments are coming so rapidly in the radio field that those things which are in vogue today are out of date tomorrow. Indications point out, however, that so far as the vacuum tube is concerned, there is little doubt but that it will be operated in the future from 110-volt alternating current circuits probably through the medium of step down transformer.

* * *

Car Lighting Equipment Manufacturers

From the best information obtainable the addresses of the car lighting equipment manufacturers are as follows: Brown Boveri system—manufactured at Baden, Switzerland by the Société Anonyme Brown, Boverie & Cie—also manufactured in France; Consolidated system, types A, D & L can now be obtained from the Electro Dynamic Company, Avenue A, Bayonne, N. J.; Dick system—originally manufactured by the Austrian Siemens-Schuckert Works and to the best of our knowledge, still is. The information we have came from Dr. Max Büttner, Berlin, Germany. Presumably, he could also answer questions regarding the Büttner system; the General Electric Company, Schenectady, N. Y., manufactures the General Eelectric head-end equipment; the Gould Simplex system is manufactured by the Gould Storage Battery Company, Depew, N. Y.; the Leitner system extensively used in England and continental countries but not in the United States, can be addressed at Rotax, Ltd. Motor Accessories, London; the original Mather & Platt system which was used in Europe has been developed in this country as the E. S. B. equipment and is manufactured by the Electric Storage Battery Company, Philadelphia, Pa.; the Newbold system has been manufactured by the Adams & Westlake Company, 319 West Ontario street, Chicago, Ill.; the Pintsch-Grob system—manufactured by Julius Pintsch, 71-73 Andreastrasse, Berlin; the Stone equipment as used in this country is called the Stone-Franklin equipment. This equipment has been made by the Stone Franklin Company, Inc. but recently the business of this company was acquired by the Safety Car Heating & Lighting Company, New Haven, Conn. The original Stone equipment is of English origin and is manufactured by J. B. Stone, Ltd., Depford, London; Safety system—manufactured by the Safety Car Heating & Lighting Company, New Haven, Conn.; the U. S. L. equipment is made by the United States Light & Heat Corporation, Niagara Falls, N. Y.

* * *

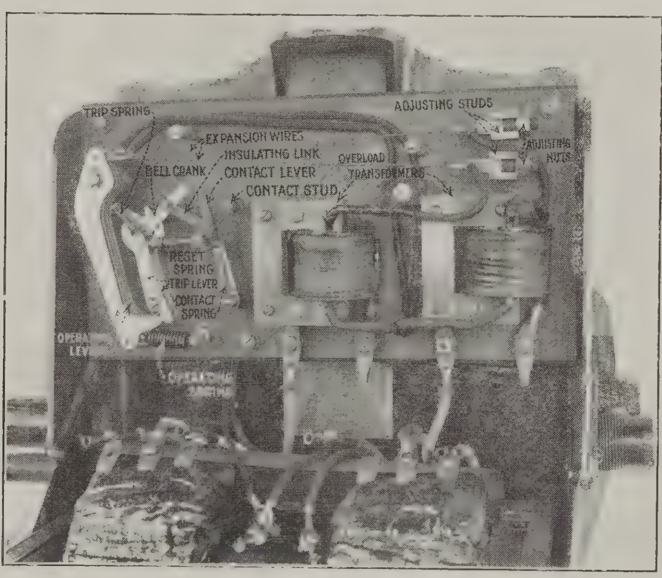
Questions for January

1. *I have been using a dry battery radio outfit with a WD-11 tube, but the batteries do not seem to last very long and I would like to get some kind of battery that would not have to be replaced every week. Would a blue stone gravity battery be satisfactory?*

NEW DEVICES

Automatic Motor Starter With Expansion-Wire Overload Device

An automatic induction motor starter, known as No. O compensator, for wall or pipe mounting, with an expansion-wire overload device has been developed by the Electric Controller & Manufacturing Company, Cleveland, Ohio. The starting mechanism in this compensator is similar to that used in the No. 1 and No. 2 compensators manufactured by the same company. The motor is started and stopped with a push button. When the starting button is pressed the first operation of the compensator causes a reduced voltage to be applied to the motor terminals and after the motor has come up to speed and its current has fallen to a predetermined value,



The Expansion Wire Overload Device

full voltage is applied to the motor terminals automatically.

The No. O compensator is made with and without overload protection in two types known as form B and form A respectively. Both types are equipped with no-voltage release.

The expansion-wire overload device is unique. The expansion wires which are anchored at the right are fastened to the upper end of the operating levers and the pull of the expansion wires is balanced through an equalizer by the pull of the operating spring. The expansion wires are surrounded by a protecting case to insure uniform heating of the wires. The lower ends of the operating levers engage a common trip lever to which is fastened a reset spring which pulls the trip lever toward

The No. 0 Form B Automatic Motor Starter. The Raised Portion at the Top of the Case Contains the Overload Device

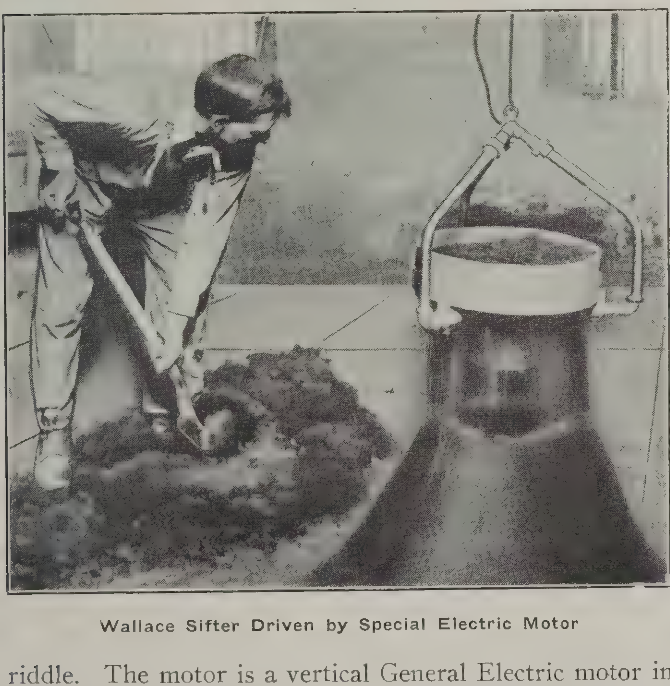
the right. The forked end of the trip lever moves the contact lever by means of the bell crank and insulating link to the right or left as the trip lever moves to the right or left. Lost motion between the forked end of the trip lever and the bell crank, aided by the trip spring, provides a quick make and break between the contact lever and the contact stud. The contact spring effects a wiping contact. The circuit of the compensator operating coil passes through the contact lever and the contact stud so that when they are in engagement the operating coil can be energized and when they are not touching, the circuit of the operating coil is opened.

The operation of the overload device is as follows:

normally the device is in the position in which the contact lever engages the contact stud, allowing current to pass through the operating coil, for closing the compensator when the start button is pressed. With the compensator closed and current flowing to the motor, secondary current also flows through the expansion wires. This current causes these wires to heat and lengthen, but as long as the current is below the value at which the device is adjusted to operate, this increase in length is insufficient to effect operation. When the current increases above the operating value, the heating causes the wires to lengthen so much that the contact lever and the contact stud disengage, thus opening the circuit to the operating coil and causing the compensator to open its contacts, disconnecting the motor from the line. When the motor current ceases to flow in the circuit, the expansion wires cool and shorten and the operating levers move back to their normal positions.

A High Capacity Electric Sifter

A forward step in foundry practice is taken with the advent of an electric sifter made by J. D. Wallace & Co., Chicago. The Wallace electric sifter is said to sift a ton of moist molding sand in four minutes through a No. 2 riddle, delivering the sand perfectly cleaned and thoroughly mixed. The light weight of the sifter permits it to be hung from any convenient support at any desired height and a molder can easily move it over his sand pile, or sift directly over core trays or flasks. The greatest vibration is only 5/16 in. from its vertical position. The drive is by means of a special electric motor connected direct to the



Wallace Sifter Driven by Special Electric Motor

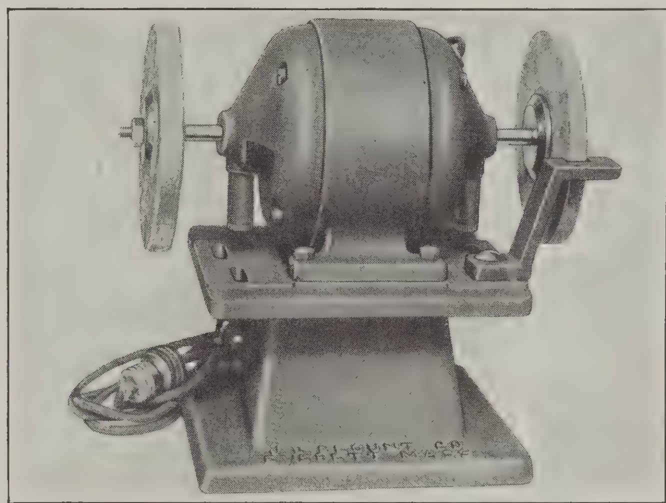
riddle. The motor is a vertical General Electric motor in which the armature and shaft remain stationary and the field and housing revolve at high speed. The housing, being weighted on one side results in an extremely rapid and regular vibratory motion to that of an eccentric flywheel.

This motor is enclosed in a dust and grit proof casing and cooling air is circulated around the motor by its own peculiar motion. The air is drawn in at the top of one arm of the supporting frame tubing and after circulating around the motor is expelled at the top of another arm. A valve trap at the air intake prevents dust and dirt entering the motor.

The machine comes equipped with an 18-in. riddle with No. 2 screen which can be readily changed or removed by simply loosening the riddle clamps. The Wallace electric sifter should prove of value in railroad iron or brass foundries because of its time- and labor-saving features, coupled with portability, light weight and sturdy construction.

Bench Type Motor Grinder and Buffer

Designed to operate on either alternating or direct-current circuits, a new combination motor grinder and buffer of the bench type has been developed by the J. G. Blount Company, Everett, Mass. This machine is provided with so-called Blount special plain bearings and a standard Westinghouse single-phase, ¼-h.p. motor de-



J. G. Blount Bench Type Motor Grinder and Buffer

signed to run at 1,800 r.p.m. The machine runs on alternating current, either 110 or 220 volts, 60 cycle, or single-phase. Thirty-two, 110, or 220-volt direct current can also be used.

This range of voltages makes the grinder suitable for almost any location.

A substantial base is provided for this machine, of ample strength and weight sufficient to minimize vibration. The flanges are machined all over to insure balance. The grinder has a pan to support the guards and rests. The guards can be furnished for either side for use with grinding wheels and an extra rest for the left side if it is required.

The buffing wheel is of the standard make and is placed on the left side of the machine. The equipment furnished with this grinder consists of one 6-in. by ½-in. standard grinding wheel, medium grit; and two rests for right-hand side; one 7-in. by ⅜-in. buffing wheel (sewed); and attaching cord with standard plug.

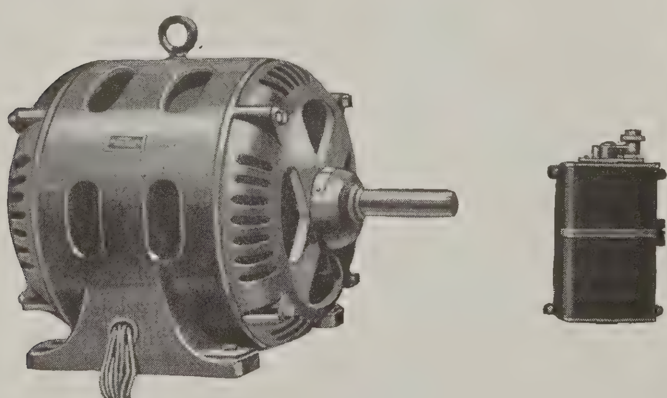
This combination grinder and buffer is a convenient bench tool, being adapted to use in almost every department of railroad shops. For grinding tools, small castings and small machine parts, also for buffing operations it should prove convenient and adaptable.

Multi-speed Alternating Current Motors

The Louis Allis Company, Milwaukee, Wis., is announcing a new line of multi-speed induction motors which provide for speeds of 600, 720, 900 and 1,200 r.p.m. The principal point of distinction claimed for these motors is the introduction of the 720 speed.

The multi-speed motor is of the squirrel-cage type, having a rotor similar in construction to that of the standard single speed polyphase squirrel cage motor manufactured by the same company. The external appearance of the motor is identical with that of the standard induction motor except that additional leads are brought out from the several stator windings. The motor is built for either two, three or four speeds. A separate stator winding is used for each speed, giving approximately the same operating characteristics as the squirrel cage motor running at this particular speed. As each stator winding is independent of the other, the winding may be designed for any required horsepower at that speed, providing the capacity for that particular motor frame size is not exceeded. The motors are designed for constant horsepower, constant torque or any combination of both.

The standard single speed squirrel cage motor when wound for three phase current has three stator leads. The multi-speed motor has one common lead and two leads for each of the various windings. The changes in speed are accomplished by a simple drum controller for either two, three or four speed motors. In the case of a two-speed motor for non-reversing service it is only necessary to use a three-pole double throw knife switch for speed changing. The drum controller is so designed that any selected winding of the motor may be connected to the line giving the desired speed. The windings not in use at any particular moment are open. The manufacturer states, however, that no appreciable voltage is generated in these windings during this period.



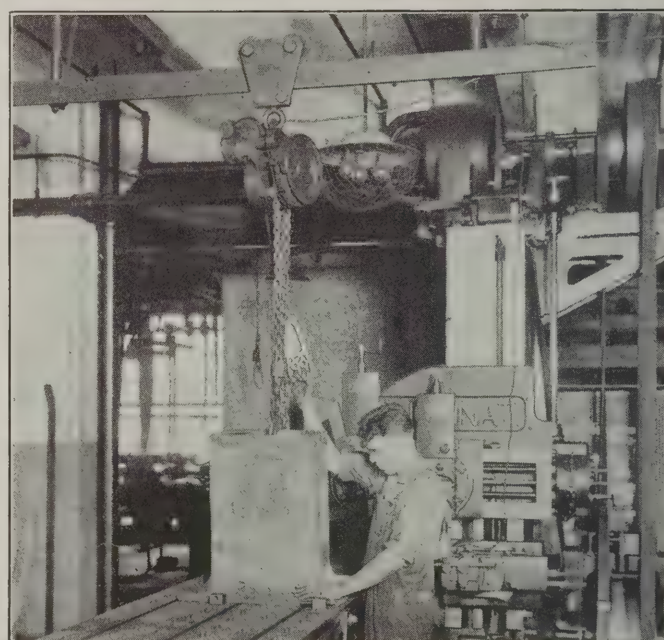
Watson Multi-Speed Induction Motor and Drum Controller

The starting or protecting device used with the multi-speed motor may consist of any standard or automatically controlled switch which is adapted to a single speed squirrel cage motor. In the case of a constant horsepower multi-speed motor which has the same horsepower rating at all speeds, one set of overload relays on the starter will afford protection throughout the complete speed range. With a constant torque multi-speed motor it is necessary to supply an additional set of relays for each stator winding; if overload protection is to be provided at all speeds. The speed changing device, which may consist of a knife-switch or drum controller, is a separate unit of control and except in the case of automatic control is used for speed changing only. The manufacturers offer several different types of automatic control for these motors consisting of the drum controller and an automatic starting panel. For automatic control, the drum is provided with auxiliary contacts which actuate the starter at the proper intervals.

The motors are built in sizes of from 3 to 15 h.p. for either three-phase or two-phase current with one exception. Two winding four-speed motors in which the speed changes are accomplished by polar grouping are suitable for three-phase operation only.

Motor-Driven Chain Hoist

An electrically-operated material-handling device, known as the Motorbloc, has been placed on the market by the Motorbloc Corporation, Summerdale, Philadelphia. This device has been developed to serve the operations lying between the field of standard hand chain hoists and traveling electric hoists. The Motorbloc is a rugged and readily portable hoist, which can be installed without engineering preliminaries in any location where electric current is available. It is put in service with the facility of an electric drill or vacuum cleaner, and the self-contained pendant controller permits convenient operation as soon as the cord has been plugged into the nearest electric circuit.



Motorbloc Hoist As Used in Machine Shop

In the design, great care has been used to avoid stressing the hoisting mechanism beyond the loads and speeds for which it is proportioned for hand operation. While completely removing the labor from the hoisting operation, the electrification is said actually to reduce the wear on some of the vital parts.

The Motorbloc consists of a standardized chain hoist of steel construction, electrified by the application of a specially designed heavy duty motor, liberally proportioned reduction gearing and slip friction clutch. This mechanism is applied by means of a malleable iron supporting bracket, comprising a self-contained electrifying

unit, to which the pendant controller is also attached. In this way a simple, rugged mechanism has been developed for the electrification of the standard spur-geared chain hoist in capacities ranging from ¼ to 10 tons. The proportions are such that the device will stand up under severe overloads and abuse to which portable apparatus of this character is subjected by common labor, generally unfamiliar with the handling of power machinery.

Extreme care has been given to features of compactness, symmetry and balance, combined with lightness and strength through the use of high grade materials, liberally proportioned to meet the most severe service conditions. The armature shaft and worm are carried in heavy duty ball-bearings and liberal provision has been made for adequate, automatic lubrication.

The self-contained pendant controller is easily operated by the fingers of one hand, leaving the other hand free to guide the load. This arrangement makes it possible for one man, without physical effort, to accomplish what would otherwise require two or more men for lifting and placing the same load.

The simplicity of this mechanism is promoted and the operation safeguarded by the use of the ring-oiled slip friction clutch which prevents damage from over-running to the hoist parts and chain and at the same time completely protects the motor from overload, without the complication of an electric limit switch.

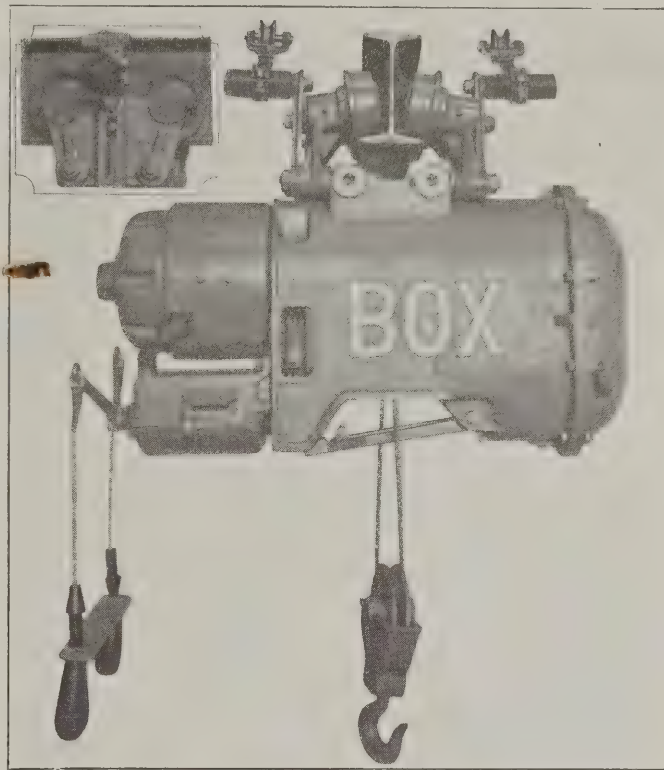
The illustrations show the Motorbloc built on a Franklin-Moore all-steel suspension spur-geared chain hoist. For occasional use at points where electric current is not available, or in the event of the temporary failure of electric power, the hand chain can be quickly applied, and the hoist operated as an ordinary block.

Half-Ton Electric Hoist

An electric hoist of substantial but simple construction, handling loads up to 1,000 lb. and known as the Load Lifter, has been developed by Alfred Box & Company, Inc., Philadelphia, Pa. This hoist has a lifting speed without load of 30 ft. per min.; with 500-lb. load, 32 ft. per min., and with 1,000-lb. load, 20 ft. per min. The standard lift furnished is 15 ft., the maximum being 39 ft.

Many advantages are claimed for this electric hoist, among which may be mentioned automatic lubrication from one point. By an ingenious combination of the splash and force feed system, it is only necessary to pour oil into the housing at one point and then only about once in six months. All operating parts are enclosed and the unit is highly efficient due to the use of flexible and self-alining ball bearings throughout. The lack of complicated mechanism eliminates the necessity for adjustment after installation. Improved load brakes control and hold the load automatically, and the load may be moved a fraction of an inch in either direction by proper co-ordination of brakes and controller. This is provided for automatically so that the hoist may be safely operated by any person. The controller is of special design, being of rugged construction and totally enclosed in a waterproof housing.

The Load Lifter takes up little more space than the ordinary chain block. Adjusting trolleys are provided and an interchangeable upper hook and trolley. Any Load Lifter may be easily converted into either hook or trolley suspension, the two types being interchangeable. To prevent overwinding of the hoist hook and subsequent damage, an improved upper safety stop shuts off the current from the motor and applies the hand brake so that the hoist instantly stops. The rope may be readily re-

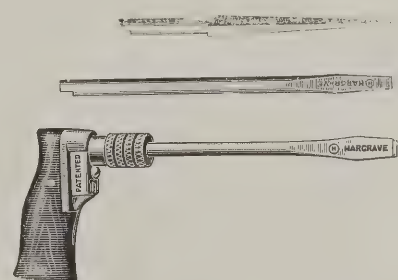


Simple Compact Electric Hoist; Capacity Up to 1000 Lb.

moved from the winding drum but, on account of deep flanges, cannot come off the drum accidentally or become wedged between the drum and the frame. A totally enclosed one horsepower motor, built especially for severe hoist service, is used.

Pistol-Grip Ratchet Screw Driver

A ratchet screw driver with pistol grip has recently been placed on the market by the Cincinnati Tool Company, 1951 Waverly avenue, Norwood, Cincinnati, Ohio. The set consists of handle, two blades and reamer. Two



Ratchet Screw Driver, Extra Blade and Reamer

widths of blades are furnished to fit common size screws and the reamer is handy in starting screws and similar work. Easy running screws may be quickly turned without taking the hand from the handle with the knurled ferrule. The pistol grip being a natural grip does not tire the hand in same way in which the ordinary screw driver does.

General News Section

The New York Central has recently ordered ten motor cars for suburban service from the Standard Steel Car Company.

The Long Island has ordered 48 motor cars and 20 electric trailer cars for surburban service from the American Car & Foundry Company.

The Westinghouse Electric & Manufacturing Company announces the employment of E. B. Brandt as work manager of the new plant which is being erected at Homewood, Pittsburgh.

The Standard Underground Cable Co., Pittsburgh, Pa., announces the removal of its Boston sales office from quarters in the Delta Building to 609-612 Unity Building, 185 Devonshire street. F. C. Cosby is manager of the Boston office.

The Westinghouse Electric & Manufacturing Company has leased a six story building to be erected in Atlanta, Ga., at a cost of $360,000. The building, which is to be known as the Westinghouse Electric Building, will be constructed according to the company's specifications and will be used as an office, warehouse and service station. Construction work was started December 1 and will probably be completed by next May.

The Pau-Tarbes line of the Midi Railroad of France is now completely electrified and the electrified section will be extended to Montrejeau by March and during the summer of this year, the Dax-Toulouse line will be electrified according to statement made by the director of the Midi Railroad. According to the Minister of Public Works, the Southern Railroad is committed to the electrification of 3,000 kilometers of track at an early date and the Orleans and Paris-Lyons-Mediterranean lines have undertaken a similar promise.

An announcement has been issued that the Safety Car Heating & Lighting Company has acquired the business of the Stone Franklin Company, Inc., for the United States and Cuba, and will in the future be in a position to supply Stone Franklin equipments where required and the necessary spare parts for the maintenance of equipments now in service. Samuel G. Allen, vice-chairman of the Franklin Railway Supply Company, was elected a member of the board of directors of the Safety Car Heating & Lighting Company on December 6, 1922.

The Gibb Instrument Company of Bay City, Michigan, has taken over under exclusive license, the manufacture and sale of the Automatic and Semi-automatic Electric Arc Welding Machines developed and heretofore manufactured by the Fred Pabst Company of Milwaukee, under their various letters patent, and have contracted to act as selling agent for the Pabst line of patented covered electrodes. The Pabst Company has spent over two years in the development of this line of equipment, and the field of application is said to be very wide, embracing the welding of tanks, range boilers, barrels, drums and tubing. The Gibb Instrument Company has announced its intention to encompass the entire range of electric welding equipment.

A new type of Pullman car has been put in service on the Northwestern Limited of the Chicago & Northwestern operating between Chicago, Minneapolis and St. Paul. Permanent partitions extending from the side of the car half way across the backs of the seats provide greater privacy for the occupants of the berths during the daytime. The outer surface of the upper berths is flatter than usual, which gives the interior of the car an appearance of greater width. Other conveniences for the travelers, such as additional coat hooks in the upper berths and more easily operated berth lights are also provided.

The United States Civil Service Commission announces a competitive examination for the position of master electrician to be held on January 24, 1923. The examination will be held to fill a vacancy in the position of master electrician at the Navy Yard, Brooklyn, N. Y. The salary is $12.96 per day. The duties consist of executive management and direction of an electrical shop, employing about 300 men. Competitors will be rated on practical questions, rated at 50 per cent and training and experience, rated at 50 per cent. Present specified training and experience is required. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or Secretary of the Board of U. S. Civil Service Examiners at the post office or custom house in any city.

Proposed Electrification in Spain

Representatives of Morgan & Company of New York, Messrs. Rothschild of London, and Messrs Urquijo, the Spanish bankers of Madrid and Bilbao, have recently formed a company, with a capital of 500 million pesetas (approximately $100,000,000 at par exchange), to carry out the long-discussed project for an electric line between Madrid and Valencia, according to a dispatch from Barcelona to the Times (London) Trade Supplement. The line will be about 220 miles in length and double-tracked.

The project includes the development of hydro-electric power necessary for the new line, as well as the working of several mines, and other schemes of an agricultural character. It is stated that the work will be put in hand as soon as possible, embodying the proposals of the engineers, Messrs. Vallejo and Membrilla. The capital of the new company will enjoy a state guarantee of 5 per cent interest. Besides being the first electric trunk line to be constructed in Spain, the project is one of the most important of its kind that have been launched in the country for many years. The new railway will open up a

country rich in minerals and in agricultural produce but hitherto devoid of communications.

Of the Trans-Pyrenean railways which are being constructed under the Franco-Spanish Agreement of 1904, the line from Ripoll to Puigcerdá is the only section at present in working order. The Minister of Public Works has now been authorized to ask for tenders for its electrification. The line is about 40 miles in length, with two long tunnels of a total of 3.7 miles. There are eight stations, some of which are not yet complete. The line rises to a height of 3,900 ft. in the tunnel under the Pyrenees; eventually it will connect with the French lines at Aix-les-Termes and will shorten the journey between Barcelona and Toulouse by 75 miles.

Change in Name

The Dodge Sales and Engineering Company, Mishawaka, Indiana, which has for the past eight years been operating as the selling subsidiary of the Dodge Manufacturing Company and Dodge Steel Pulley Corporation, has now been consolidated with the parent company, Dodge Manufacturing Corporation, which was organized and began business last July. The distribution of Dodge products, which has heretofore been done under the name of the Dodge Sales and Engineering Company, will hereafter be conducted by the sales department of the Dodge Manufacturing Corporation with Duncan J. Campbell, general sales manager, in charge, and John A. Beynon, assistant general sales manager. The District Sales Organization of the Dodge Sales and Engineering Company will be continued as branches of the Sales Department of the Dodge Manufacturing Corporation.

The Dodge Manufacturing Corporation also controls the Dodge Manufacturing Company of Canada, Ltd., with head offices and works at Toronto, Ontario, and sales office at Montreal, Que.

Dearborn Station Damaged by Fire

Dearborn Station, Chicago, operated by the Chicago & Western Indiana and used by the Atchison, Topeka & Santa Fe, the Chesapeake & Ohio, the Chicago & Eastern Illinois, the Erie, the Chicago, Indianapolis & Louisville, the Grand Trunk and the Wabash, was damaged by fire to the extent of $300,000 on December 21. The fire was caused by crossed wires and started in the ceiling over the second floor at 3:30 p. m., spreading rapidly to the third floor and loft. The fire was confined to the upper floors of the building which were used for offices and the storage of records. It spread so rapidly that within half an hour the entire upper portion of the building was in flames. The train shed was not damaged and no mail or baggage was lost. As soon as the fire was under control, arrangements were made to handle the heavy holiday traffic with a minimum of inconvenience and delay. By 7 p. m. trains were being handled on schedule and an annex ordinarily used for the accommodation of suburban passengers was used for regular passenger traffic.

On December 23 the debris had been cleared so that passengers were able to enter the train shed through the main floor of the building. The baggage and waiting rooms were restored to service on December 24. The station was built in 1885 at a cost of from $400,000 to $500,000, and was considered one of the largest and best appointed stations in the country at that time.

Agreement with Erie Shopmen

The Erie Railroad has made an agreement with the committees of the shop crafts putting in permanent form the informal agreements which were entered into when the striking shopmen returned to work, on September 27 last. The eight-hour day is standard; eight hours' service for eight hours' pay; and the minimum rates are those prescribed in the schedule of the United States Railroad Labor Board, in which overtime work is allowed time-and-one-half. In the Erie agreement Sunday and holiday work is to be paid for at the same rates as for work done on other days.

About 200 men who have been working for less than the standard rates are to receive back pay, the agreement being retroactive to September 27.

Strikers who return to work are to retain their seniority rights *as between themselves.*

Grievances or controversies are to be settled by local committees so far as possible, with right of appeal, for final adjudication, to regional boards, one in each Erie Region, consisting of railroad officers and brotherhood representatives in equal number.

The total shop forces of the Erie system number about 9,000 men.

French-Built Electric Locomotive Undergoes Test

A trial run of a French-built electric locomotive was recently conducted by the French Ministry of Public Works. This locomotive is the first of a series of 50 which are to be built on a standardized design for railroad service between Dax and Toulouse, a distance of 220 miles. They will be constructed by the Société des Constructions Mecaniques which recently established works at Tarbes where 900 men are now employed. The site on which the Tarbes plant has been erected was unoccupied only fifteen months ago.

It is expected that the section of the Midi Railway between Dax and Toulouse will be completely electrified during 1923. Progressively the whole of the Midi, P.L.M. and Orleans systems representing a total of about 5,750 miles of line, will be similarly transformed. This scheme for the electrification of the railways is being carried out in conjunction with the undertaking for the utilization of the rivers Rhone and Dordogne for the development of electric power, generally. The substitution of electricity for steam as a motive power on the railroads will enable France, according to official estimates, to reduce her imports of coal by about 3,000,000 tons a year.

Cost of Installing and Operating Electric Traction Equipment

Steam Road Electrification was the title of an address presented by A. H. Armstrong, chairman electrification committee, General Electric Company, before the New York Electrical Society on Tuesday, December 19 at the Engineering Societies' Building in New York. Mr. Armstrong stated that the saving in coal effected by electric operation should offset the additional cost of the electrical equipment. Electrical operating facilities exclusive of

locomotives, he stated, cost just about as much as the electric locomotives themselves, while steam locomotive operating facilities, not required when a road is electrified, cost about one half as much as the locomotives. Electrification, he said, in a given case, should save about 20 per cent in operating costs as compared with steam, 12 per cent of which was effected by reduced maintenance costs.

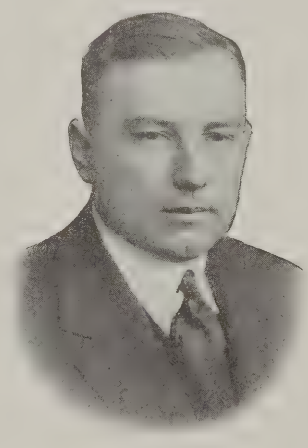
Mr. Armstrong also elaborated upon the better known advantages of electric operation, such as increased track capacity, improved terminal facilities, improved operation, etc. He also pointed out the fact that the great majority of steam road terminals were of a necessity on the outskirts of cities and he stated that electrified terminals centrally located would minimize truck competition.

Personals

H. E. Dalzell, recently chief mechanical and electrical engineer for the Southern Railway of Peru, is taking an eight months' holiday following 15 years of service in the tropics. In the spring, after completing the holiday, he will take a position on the east coast of South America.

Geo. L. Bebout, formerly electrician on the Chesapeake & Ohio at Ashland, Ky., has accepted a position as electrician for the Aero Fire Alarm Company at Newport News, Va. He is at present engaged in installing an Aero fire alarm system on the steamer Leviathan.

J. M. Spangler, manager railroad sales division of the National Carbon Company, Inc., with headquarters at Cleveland, Ohio, has been appointed assistant district manager, with headquarters at Chicago. Mr. Spangler was born at Middleburg, Pa., on December 2, 1889. He graduated from the electrical engineering department of Pennsylvania State College in 1911, and began railway work in the signal department of the New York Central Lines in the same year. From 1913 until 1915 he was connected with the Railroad Supply Company, Chicago, as sales representative in the signal department. In 1915 Mr. Spangler was appointed southwestern railroad sales engineer of the National Carbon Company, Inc., and in October, 1919, he was promoted to manager railroad sales division, which position he held until his recent promotion. He will be succeeded by **A. E. Pratt,** assistant manager railroad sales division, with headquarters at Cleveland, Ohio, whose photograph and sketch appeared in the *Railway Electrical Engineer* of January, 1922, page 41.



J. M. Spangler

Louis W. Sipley, commercial engineer in the Philadelphia, Pa., office of the Safety Car Heating & Lighting Company, has resigned to become affiliated with A. J. Forschner in the Alfred J. Forschner Company. This company will have its headquarters in the Real Estate Trust building, Philadelphia, Pa., and will be sales agent for a complete line of construction equipment and contractors' supplies.

Fred M. Rosenweig, who has been located in the Chicago office of the Regan Safety Devices Co., is now located in Niagara Falls, N. Y., with the same company, as engineer in charge of development work.

Obituary

William Jared Clark, advisory manager of the railway department of the General Electric Company, having been active in the management of that corporation for many years, died at his residence, 251 W. 92nd St., New York City, in his sixty-ninth year. He was born at Derby, Conn. He was a pioneer in the commercial development of electric railways, and helped obtain the charter for the first one designed for freight traffic. During his long service with the General Electric Co. he had been manager of its railway and foreign departments and manager of its London office and was active in politics for many years.

Trade Publications

The Ohio Brass Company, Mansfield, Ohio, recently issued a four-page folder illustrated in colors and describing the design and application of the high tension porcelain strain insulators which it manufactures.

Control Signaling and Alarm Instruments.—The Brown Instrument Company, Philadelphia, Pa., has issued a 24-page booklet describing and illustrating the automatic control, signaling and alarm instruments manufactured by that company. The catalogue covers a control pyrometer as applied to electric, gas and oil furnaces, indicating control thermometers, a recording control thermometer, a recording pyrometer, a signaling pyrometer which shows by means of light when the temperature is within certain prescribed limits, an alarm thermometer, control relays and a motor operated control valve.

Electrical Communication.—A new monthly publication called "Electrical Communication" has been launched by the International Western Electric Company, intended particularly for distribution in foreign countries. The purpose of the publication is to give a clearer picture of the communication profession to foreign government officials interested in telephone and telegraph work, to public utilities of foreign countries and to educators. The titles of the articles in the first issue are as follows: Recent Developments in Electrical Communication; Telephone Repeaters; The Dynamical Theory of Amplifying and Oscillating Systems; A New Type of High Power Vacuum Tube; A Unique Demonstration of the Public Address System; Some Notes on Statistics; Rehabilitation of the Antwerp Factory; Analysis of the Energy Distribution in Speech; The Nature of Speech and Its Interpretation.

Railway Electrical Engineer

Volume 14 FEBRUARY, 1923 No. 2

Opportunities Knock for the Electrical Man

The electrical engineer on the steam railroad of today is a man upon whom much of the development of the road during the next 10 years will depend. There is no longer any doubt but that electricity is going to be generally recognized as a great necessity in the operation of an increasing number of railroad functions. The amount of electrical equipment which the various roads have purchased and which they are continuing to purchase is stupendous. Each year has seen an increase in the quantity of electrical material put into service until today practically every department on the road has some electrical appliances which it feels that it could not get along without.

During the period that all of this equipment has been going into the various departments of the road, the electrical engineer has been gradually acquiring a higher place among railroad officers. This is as it should be, for the railway electrical engineer of the future will be a man who of necessity must rank high not only in the qualifications of his profession, but he must be a man who has the ability to grasp the larger aspects of economical railroad operation. It is not enough for him to be familiar only with the details of electrical work, but he must know how these details fit into all of the numerous and varied activities of railroad life.

The electrical engineer of the future has a great opportunity, but to realize this fully he must necessarily become much more aggressive than he is at present. It is unfortunately true that many electrical engineers today do not assert themselves in the way in which they should. Meek and retiring qualities will not get very far in securing recognition and prestige. The great trouble with the majority of electrical men on steam railroads is that they avoid everything that would naturally bring them into the spotlight of publicity.

One of the most dignified ways in which any technical man can acquire recognition in his particular field is through the publication of articles written by him and which bear upon his profession in technical periodicals, or club or engineering society proceedings. It is really surprising to see how few men avail themselves of these opportunities. The art of writing technical papers is a thing which every engineer should be capable of doing.

The preparation of an engineering report does not differ very greatly from the general technical articles which are found in the various trade and business papers. There is no good reason why electrical engineers on steam roads should not prepare similar articles for publication or presentation at various club and technical society meetings. Not only would they enjoy a certain prestige by so doing, but in describing their experiences or methods of accomplishing unusual engineering results, they would add materially to the sum total of useful information so that all could profit by their knowledge. The electrical engineer of the steam railroad today is sadly remiss in this matter of writing for publication; in neglecting this opportunity, he is passing up one of the best and surest methods of advancing himself and raising his profession to a higher level.

Six-Volt Cab Lighting

It cannot be said that six-volt lighting of locomotives is new for it will be remembered by many that years ago when electric headlights were first tried, a six-volt circuit was used. It will also be remembered that at that time the lighting was practically confined to headlights alone and that little or no attempt was made to illuminate the cab. At all events six-volt lighting did not prove successful for it was never very widely adopted. Undoubtedly, conditions which existed at the time this original six-volt installation was tried were quite different in many respects from the conditions which exist today and for this reason any comparison between the original six-volt operation and that described on page 45 of this issue should be made only after giving consideration to the changes which have been effected as the years have gone by.

The source of six-volt current is quite different in this installation from what it was originally. Six-volt current derived from an alternating current generator is something entirely different from six-volt current taken from any direct current machine, and this is particularly true with the type of generator used for locomotive lighting. It is decidedly an innovation in cab lighting and those who are responsible for its trial should be encouraged in extending their experiments. Naturally enough the usefulness of the six-volt cab circuit will appeal in different degrees to different men. Some probably will be more or less indifferent to it; others may be decidedly against it, while there are still others who will believe that it is an excellent scheme. It has been suggested by one engineer who was not convinced of the practicability of the six-volt cab lighting circuit that a single lamp might be mounted in the rear of the cab near the roof in such a way as to throw its light over the entire back head of the boiler, incidentally lighting the various fixtures and gages in a

manner not unlike that of the ordinary flood lighting lamp. There is little doubt but that this method of lighting would also meet with many objections.

What may be the future of the six-volt cab lighting circuit is difficult to predict but it is, nevertheless, a fact that this unique application possesses certain merit and it is only by such experimentation that valuable ideas are brought to light which afterwards become standard practices.

Teachings of Experience

Rapid development of electric traction was prevented by the war; since that time other factors have retarded development. This is true for nearly every country in the world in which electric traction has been tried or is in contemplation. This period of comparative inaction has, however, permitted experience in practical operation to be gained with unexpectedly heavy traffic which had to be handled with reduced facilities. For example, the shopmen's strike demonstrated the dependability of electric traction equipment and showed that it could be made to operate satisfactorily over comparatively long periods when maintenance was of necessity deferred. A report was presented recently before the Institution of Civil Engineers in England by Henry Walter Huntingford Richards, covering the experience gained by 12 years' operation of electric traction on the London, Brighton & South Coast Railway. The two following statements from the paper are especially pertinent: "On electrified sections where there is no steam traffic, the renewal of catenary and dropper wires necessitated by corrosion is only about 10 per cent of that on sections where a heavy steam traffic is still running." "It is found that a new motorman can obtain a working knowledge of the control system in from two to three weeks."

Civil engineers in the United States have recently started to take a hand in the development of electric traction and a preliminary report was presented to the American Society of Civil Engineers on January 17, 1923. This report states that in the opinion of the committee, electrification of steam railroads is not primarily or even largely a question of the choice of a particular system or the type of electrification; but on the contrary, and especially at this time, it is more largely dependent on financial and economic conditions. The report states also that if these conditions in any case justify the cost of electrification, little or no difficulty would be had in the selection of the system or type of electrification which would reasonably meet the requirements.

It is quite generally recognized that electric operation has progressed beyond the experimental stage and has demonstrated its ability to increase track capacity, relieve tunnel congestion, increase suburban traffic, decrease operating expense, minimize the effect of bad weather conditions, etc. Enough information and experience is now available to make the findings of an investigating committee or commission accurate and the possibilities in the use of electric power should not be overlooked. Electric motive power is a comparatively new tool for the railroads, but when used in the right place, there is no question but that the savings will more than offset the additional capital expenditures required.

Welding Cast Iron

Welding cast iron is a form of applied science which is of great value to railroads, particularly because it has made the repair of broken parts practicable. Broken castings which were previously scrapped are now repaired *in place* and made fully as strong as they were originally.

Before the advent of autogenous welding, iron castings were repaired with brass patches, but this method was limited in its application and the work when completed could not be compared with a welded job. Both the electric arc and the gas torch are now used extensively for welding cast iron with a ferrous metal electrode or rod and the results obtained by both methods are highly satisfactory. As might be expected, both methods have their limitations. Before the casting is repaired with the electric arc the edges to be welded must be Vee'd out and fitted with rows of steel studs. Welding cast iron with the gas flame and a ferrous rod requires that the casting be preheated and if the work is being done on a locomotive cylinder, the preheating will probably warp the casting so that the cylinder bushing will have to be renewed.

Tobin bronze applied with the gas flame is now finding much favor for the welding of cast iron, particularly as applied to locomotive cylinder repairs. Strictly speaking, it is probably not a weld, but something more akin to brazing. Sections of castings repaired in this fashion, when tested for tensile strength, have broken outside the weld. Furthermore, the work can be done much faster than is possible by any other method and the only preheating necessary is to take the chill off the casting—it is heated until it is a little too hot to bear the hand on it. This does not warp a locomotive cylinder to the extent that a new bushing is required.

Comparatively few electrical men are interested in welding with the gas torch, but many will be interested in the use of bronze for welding cast iron, as successful experiments have been made for applying it with the electric arc and it will probably not be long before it will become common practice. Already Tobin bronze has become the commonly accepted method of repairing broken castings by those who were first to experiment with it, and while at present the work is confined almost exclusively to the gas torch it is inconceivable that this should be its limitation.

New Books

Electric Power Plant Engineering—By J. Weingreen, third edition, 511 *pages, illustrated, 6 in. by 9 in., bound in cloth. Published by the McGraw-Hill Book Company,* 10*th Avenue and* 36*th Street, New York, N. Y.*

The book is essentially a record of current American practice in power plant engineering. It is intended to provide information on practical problems connected with the control of the generation and distribution of electrical energy. Theoretical discussions have been reduced to a minimum. This third edition has been completely revised and new material has been added on the subject of oil switches, air switches, lightning arresters and outdoor sub-stations. The material covering reactive coils and synchronous condensers contained in the book has been considerably increased.

The Turntable Serving the 30-Stall House Has an Electric Tractor and a Dead Engine Hauling Device

A Highly Developed Enginehouse Lighting System

New York Central House at Solvay Has Lights That Illuminate Without Glare

THE wiring system of the New York Central enginehouse at Solvay, near Syracuse, New York, distributes power for motors, for motor-generator welding sets and for lighting units that really furnish enough light and distribute the light where it is needed. A sufficient number of switches of a rugged type also make it convenient to burn only the lights that are needed where a certain piece of work is being done. All machinery requiring power for operation is motor driven except for the air compressors which are steam driven.

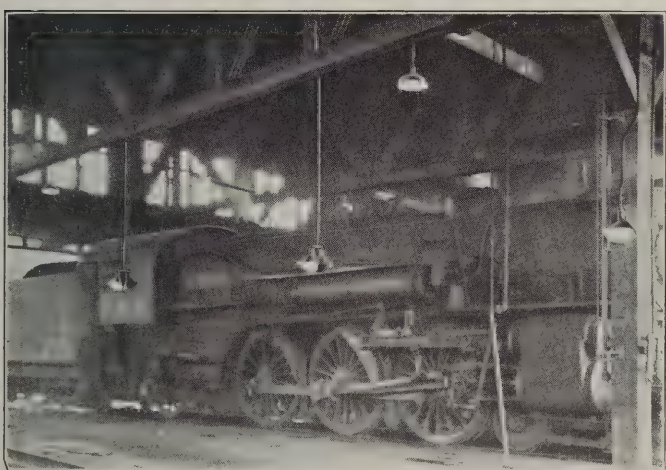


Fig. 1—Eight Lighting Units Are Located Between Adjacent Stalls

The enginehouse proper has 30 stalls, five of the stalls being 125 ft. long, and 25, 110 ft. long. A drop pit in the 125-ft. section serves three of the stalls. Immediately adjoining the enginehouse there is a well equipped machine shop, offices, locker rooms and an oil house. There is also a modern power plant, ash pits and a coaling plant. The power plant supplies hot air for heating, steam, compressed air and houses the boiler washing system for taking care of the locomotive boilers. The ash pits, four

Fig. 2—The Angle Reflectors Supply Good Lighting Where It Is Most Needed

in number, are wet pits built of concrete and are circular in form. Three of these pits are located under the inbound engine tracks and one under one of the outbound

tracks, thus providing ashing facilities for outbound power. The coaling plant is of reinforced concrete and steel throughout, making a fireproof structure with a rated storage capacity of 1,000 tons. Coal is dropped from hopper bottom cars through breaker bars to two bucket conveyors which carry it up to two circular concrete storage bins. All of the hoisting machinery is in duplicate and is driven by alternating current motors. The storage bins serve six tracks.

The turntable is of the balanced type and is 100 ft. long. It is turned by a 30-hp. motor operated tractor mounted at one end of the table and is also equipped with a device for hauling dead engines. This device consists of a winch which is located at the center of the table and which is driven by a separate motor. At the back of each stall in the outer circle wall there is a link in which the pulley block can be placed when it is necessary to use the dead engine hauling device. At the present time 85 or more locomotives are handled daily without taking into account the switching power which is also housed and handled at Solvay. The turntable and the approach tracks are lighted by floodlighting units mounted on poles, all controlled from a central point.

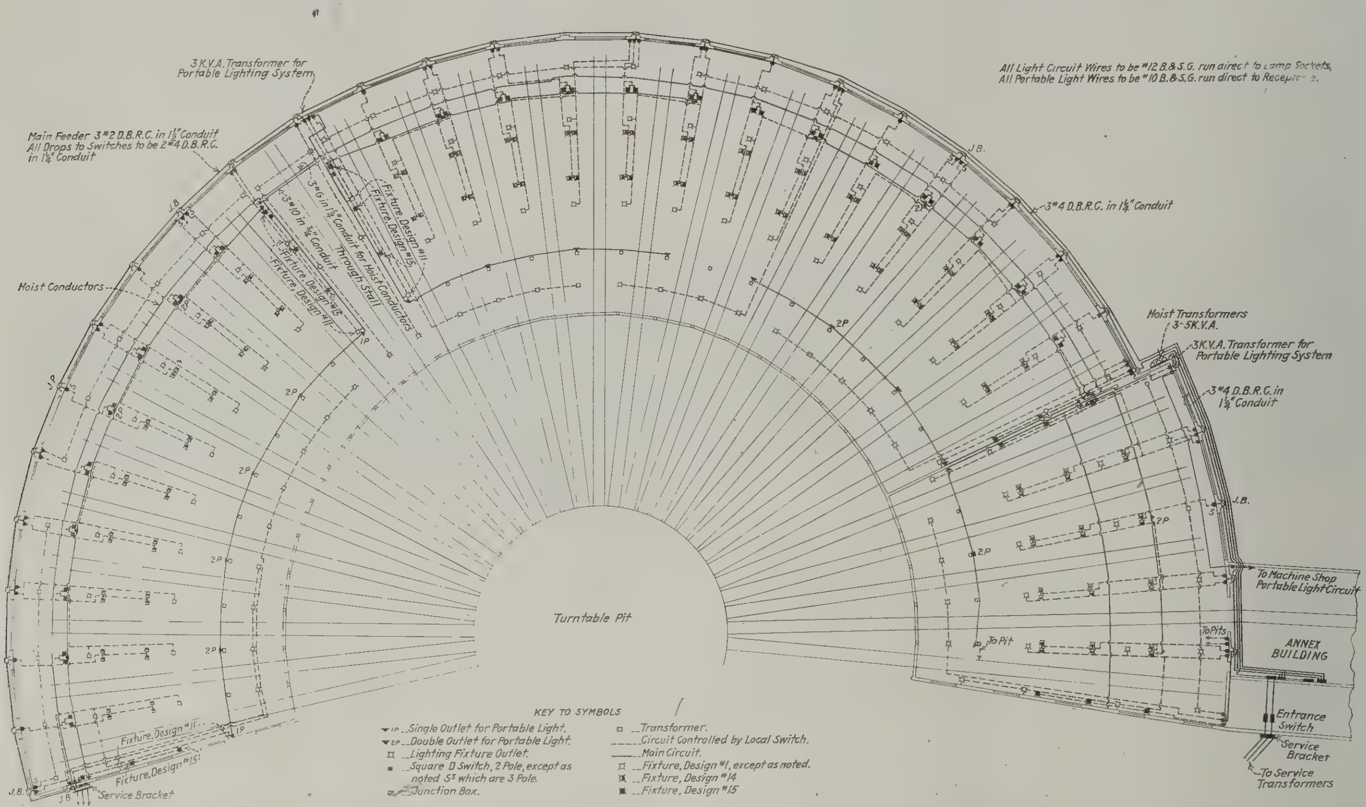


Fig. 3—Plan of the Enginehouse Showing Location of Circuits and Outlets

Power Supply and Outdoor Distribution

Electric current for lighting and power is purchased from a local power company. The high tension lines of the power company are brought into a small outdoor transformer station enclosed by a high close-mesh wire fence located a few hundred feet from the enginehouse. Adjoining the wire enclosure is a small house in which oil circuit breakers with overload trips are installed. From the transformer station the outdoor feeder lines are carried on wood poles to both ends of the enginehouse,

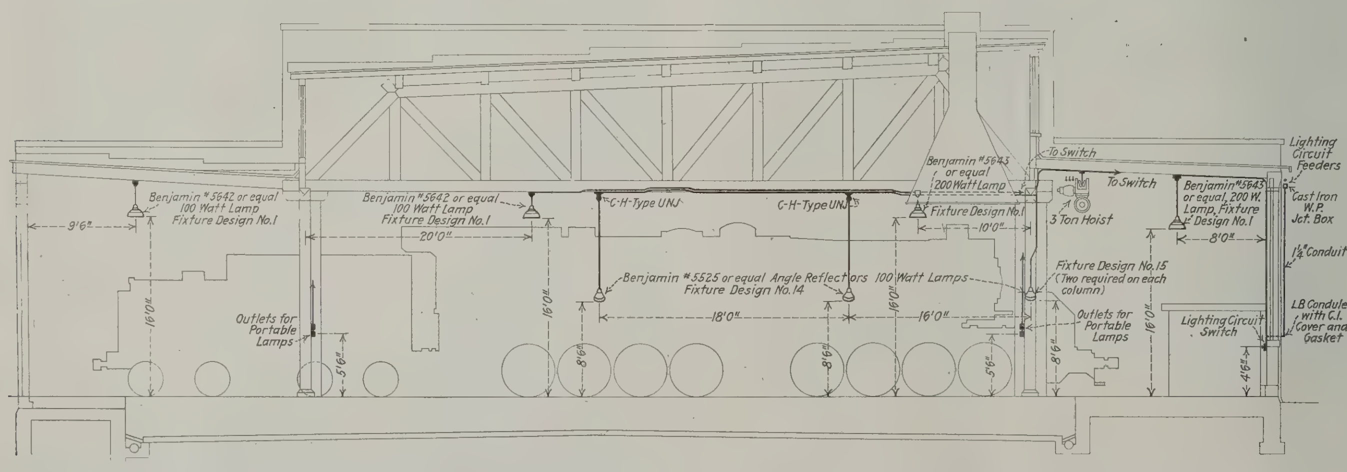


Fig. 4—Elevation of 110-Foot Section Showing Location of Lighting Units, Portable Extension Outlets and Switches

to the overhead collector of the turntable and to the coaling station. Power for operating the motor-generator sets and shop motors is supplied as three-phase, 440-volt, 25-cycle current, while three wire, 110-220-volt circuits

Fig. 5—An End-Wall of the Enginehouse Showing One of the Entrance Brackets

are used for general lighting. Circuits for portable extension lamps are supplied with 36-volt current through step down transformers.

Enginehouse Lighting Units

Probably the most remarkable feature of the installation is the kind, number and location of the enginehouse

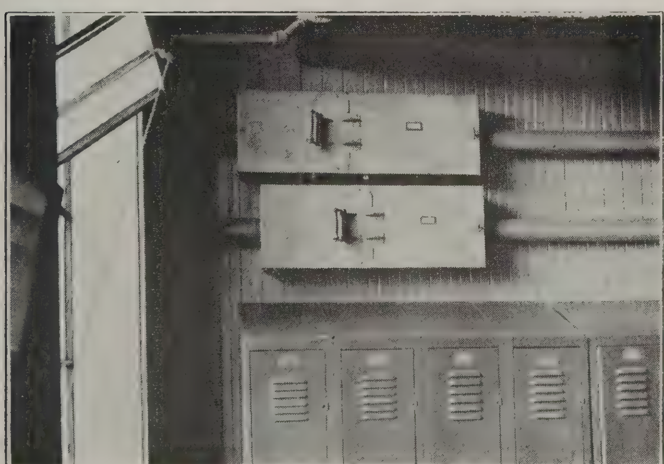


Fig. 6—Safety Type Entrance Switches in the Main Feeder Circuits Just Inside the End Wall

lighting units. These are shown in Figs. 1 and 2, and their locations are shown in Figs. 3 and 4.

The runway around the outer circle is lighted by 200-watt lamps in 16-in. Benjamin dome reflector sockets mounted 16 ft. above the floor. These are located over the center of the outer runway between stalls. The reflector is finished in white enamel inside, green enamel outside, and the socket is a two-piece, porcelain, keyless

Fig. 7—The Distribution Panels. These Are Also Equipped With Safety Type Totally Enclosed Switches

socket with a lamp grip which prevents the lamp from working loose from vibration.

Between each two stalls there are two more of the same kind of overhead lighting units also mounted 16 ft. above the floor. In addition to the overhead units be-

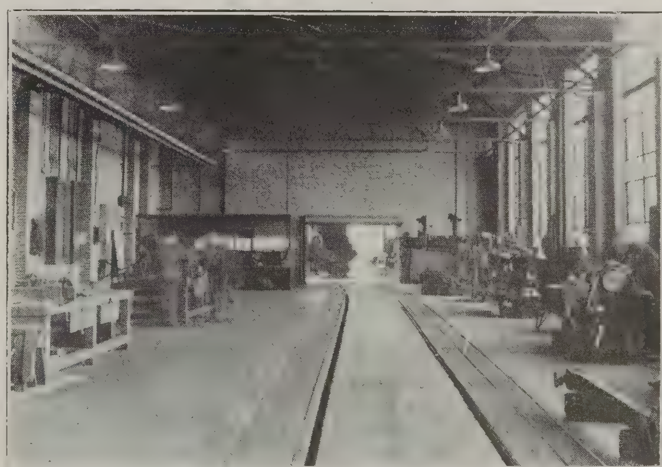


Fig. 8—The Machine Shop Which Adjoins the 125-Foot Section

tween stalls there are three pairs of Benjamin elliptical angle reflectors placed 8 ft. 6 in. above the floor. Units are hung on conduit stems as shown in Fig. 2, and where construction of the house permits, the outer pair is mounted on the post near the outer circle runway. One of the latter is shown in Fig. 1. The angle reflectors are

enameled, have the same kind of sockets as the overhead units and are fitted with 100-watt lamps.

There are two extension outlets on every other one of the outer circle of supporting posts or columns, and another pair on every corresponding column of the inner circle. The extension cords carried in the toolroom are fitted with protected portable hand lamps or with Western Electric portable utility floodlighting units on floor stands.

The three-track drop pit in the 125-ft. section of the enginehouse is lighted by eight 60-watt lamps in Oliver pit lighting fixtures which consist of cast metal outlet

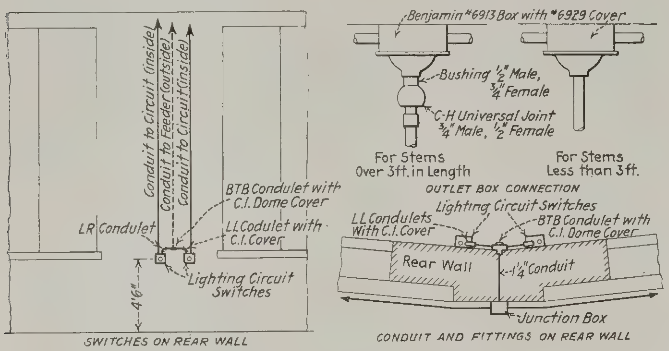


Fig. 9—Sketch Shows Methods of Running Conduit and Mounting Lighting Fixtures

box, guard and reflector. The general lighting in the drop pit section is practically identical with that in the 110-ft. sections.

Wiring

All of the wiring in the enginehouse is carried in black rigid metal conduit, painted with acid-proof paint. Conduit straps are made of Monel metal held in place with Monel metal screws. One of the two service brackets, this is the one on the machine shop end of the engine-

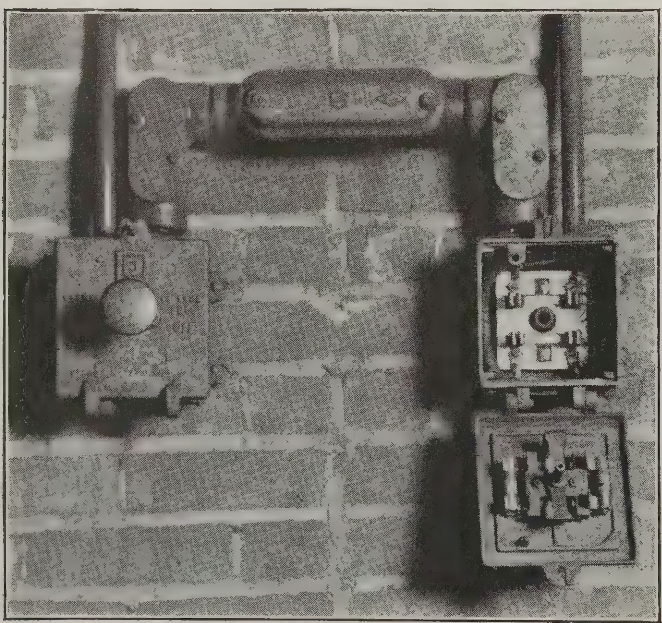


Fig. 10—Two of the Switches Which Control the Lighting Circuits

house, is shown in Fig. 5. Two type F condulets are used at the incoming end of each of the two main feeder conduits. These conduits are carried down the wall to LB condulets and then into the building.

Just inside the wall in the locker room, Fig. 6, there are two enclosed, three-pole, single throw, safety type entrance switches fitted with fuses on the load side of the switches. The covers over the fuses in the switch

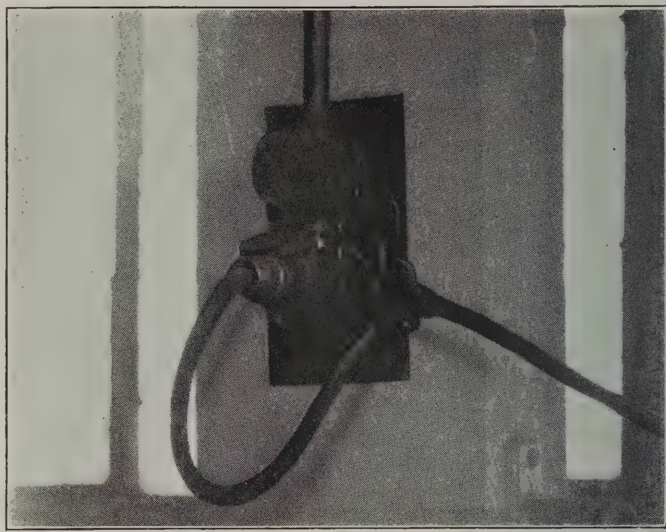


Fig. 11—A Pair of Portable Extension Outlets

boxes are interlocked with the switch mechanism so that a cover cannot be opened unless the switch is open.

From the entrance switches the feeders are carried to the distributing panels shown in Fig. 7. All circuits are controlled by safety switches, as shown, which have no exposed live parts accessible to the operator. These distribution panels are located in the machine shop, a view

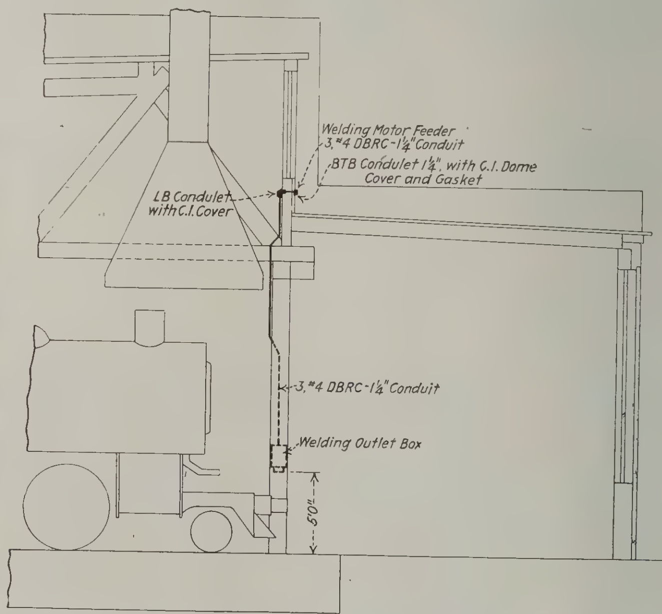


Fig. 12—Sketch Showing Location of Welding Motor Circuit

of which is shown in Fig. 8. The panels may be seen at the left, and a locomotive in the drop pit section can be seen through the door at the rear.

The machine tools in the machine shop are all driven by individual motors, most of which have push button control, and the equipment is as follows:

One double emery wheel grinder—5 hp. motor.
One 48-in. radial drill—5 hp. motor.
One 20-in. sensitive drill—1 hp. motor.

One 32-in. shaper—7½ hp. motor.
One 16-in. lathe—5 hp. motor.
One 24-in. lathe—7½ hp. motor.
One 1½-in. triple bolt cutter—5 hp. motor.

The lighting units used in the machine shop are the same type as the overhead lighting units used in the enginehouse.

The lighting feeders for the enginehouse, consisting of three No. 2 D. B. R. C. wires, are carried from the distribution panel in the machine shop outdoors around the outer circle wall in 1¼-in. conduit just under the eaves. Feeders start at each end of the enginehouse.

Junction boxes are placed in the feeder lines at points about half way between each two stalls and from the bottom of each junction box, branch feeders are run to one, two or three lighting circuits. The manner in which this is done is shown in Figs. 3, 4 and 9.

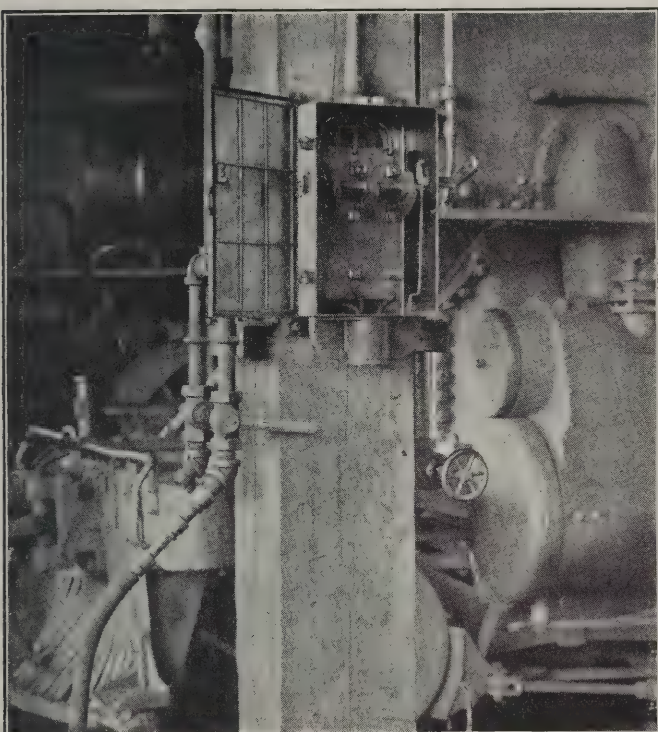


Fig. 13—An Outlet Box from Which Power Is Taken for Operating the Portable Motor-Generator Welding Sets

One of the locations in which two switches are used is shown in Fig. 10. The Square D lighting circuit switches which are used are mounted in cast-metal boxes. Pushing or pulling the operating plunger, inserts or withdraws the fuses from the clips, thus closing or opening the circuit. An extension rod on the operating handle fits into the hole in the center of the fuse block, making it impossible to open the cover unless the switch is open. The angle reflector lighting units between each pair of adjoining stalls are controlled by a separate switch; that is, there is one switch per stall for these circuits. Two of the overhead circuits between stalls are controlled from a single switch and another switch is used for about every five overhead lights over the outer circle runway. All lighting units, except for the pair on each outer column, are suspended on conduit stems, supported in turn from junction boxes. Stems more than 3 ft. long are fitted with a universal joint, as shown in Fig. 9. All branch lighting circuits consist of No. 12 D. B. R. C. wire run directly from the switch to the socket in ½-in. rigid metal conduit.

Power for the portable light circuit is obtained from two 3-kva. transformers mounted on the outer wall, one at the intersection of the 110-ft. with the 125-ft. section, and another about two-thirds around the circle. The 36-volt circuits from this transformer consist of three No. 10 wires in ¾-in. rigid metal conduit which is run in two lines completely around the enginehouse on the cross members at the top of the supporting columns, about 18 ft. above the floor. Outlets for portable lamps are mounted in pairs, as shown in Fig. 11 on every other column, at both the front and rear of the enginehouse. The two outlets are mounted on an iron plate, to which two heavy iron hooks are also secured. A strain loop is clamped to each extension cord at a point about 18 in. from the plug. When the cord is in use, the ring is placed over the hook, thus making it impossible for the user to pull the plug out accidentally or to break it by a pull from one side.

The principal reason for the use of the 36-volt extensions is to protect from shock the men who must work on wet floors or in locomotive fireboxes or in tender tanks in contact with grounded metal surfaces. An added reason is that the 36-volt lamp is more rugged than a higher voltage lamp.

Welding Circuits

The electric welding facilities consist of a 4-kw., 60/20-volt, 200-amp. arc welding generator direct connected to a 7½ hp.., three-phase, alternating-current motor. The set, together with motor starter and welding control panel, is mounted on a four-wheel hand truck and is moved from place to place where welding is to be done.

The welding motor feeder circuit, which consists of three No. 4, D. B. R. C. wires in 1¼-in. rigid metal conduit, is run from the distribution panel in the machine shop outdoors and completely around the enginehouse at a point, as shown in Fig. 12. This illustration also shows how the branch feeders are brought in to the welding motor outlets. There is one outlet on every other one of the outside circle of supporting columns. One of the outlet boxes with the switch door open is shown in Fig. 13. This outlet box consists of a safety type switch in a cast metal box with a three-pole receptacle at the bottom. The receptacle cover, as well as the switch cover, is interlocked so that the plug cannot be inserted in the receptacle unless the switch is open, and when once inserted and the switch closed it cannot be withdrawn until the switch is again opened.

In addition to the facilities described above, the enginehouse is equipped with 3-ton electric hoists for handling front ends, a 7½-ton hoist for the drop pits, and an electric crane truck for general utility service. There is a small, vertical type, motor generator set in the machine shop which is used for charging the truck batteries.

Men who think straight, act straight. Crooked thinking means crooked doing.

"The position on ahead is for the man who overflows the position now on hand."

The darkest shadows of life are those which a man himself makes when he stands in his own light.

Electric Traction Report Presented at A. S. C. E. Meeting

SEVERAL societies and associations have special committees considering various phases of the electrification of steam railroads. The American Society of Civil Engineers' committee expects to confer with such committees and, in due time, will probably establish some contacts. So far, this has not been attempted, pending a decision as to the extent to which the A. S. C. E. committee should attempt to investigate this subject, especially since it appears that other similar committees are generally confining their investigations largely to the more technical phases of this problem.

An abstract follows of the progress report on electrification of steam railroads presented by a special committee at the annual meeting of the American Society of Civil Engineers, January 17, 1923.

Why Electrify?

The broad question of the electrification of steam railroads in the opinion of the committee is not primarily, or even largely, a question of the choice of a particular system or type of electrification; but, on the contrary, and especially at this time, is more largely dependent on financial and economic conditions; that if these conditions, in any case, justify the cost of electrification, little or no difficulty would be had in the selection of the system or type of electrification which would reasonably meet the requirements.

Doubtless, there are cases which would result in benefits alike to the public and to the railroads. That this applies, in general terms, to any large number of localities or railroads is probably not true. Public interest in electrification is mostly confined to large urban districts, in the expectation that a material reduction of smoke and noise would result. Although it is true that there would be some advantages in these regards, it is possible that the results would be comparatively small in view of the many sources of smoke and noise other than railroads. There are doubtless situations, principally in large terminals and in thickly populated urban districts, where electrification may be very desirable, perhaps even necessary and where the question of the economies resulting from the change may have to be made a secondary consideration. Such situations are in a class by themselves and must have consideration independently of the larger and broader problem of the electrification of railroads over considerable distances, in order that they may be made more efficient and economical transportation agencies. The electrification of railroads by operating divisions becomes, therefore, a somewhat different and more important problem than the greater number of electrifications thus far made in the United States.

Where Economies are Effected

The economies which are usually effected by electrification do not often enter into the whole range of transportation costs, but are confined largely to the cost of power and its applications, and those items of transportation cost which are affected by a change in form of motive power and changes in operating conditions made possible thereby. One of the conditions affecting the quantity and cost of power is the volume of traffic. If this conclusion is correct, the electrification of steam railroads, where undertaken primarily as a means of increasing efficiency and economy, can be expected first on those roads, or parts of such roads, where the volume of traffic is large, or where the volume of traffic in connection with ruling gradients calls for large expenditures of power. It also appears probable that a further condition necessary to economy would be that the change from steam to electric power should be made effective over continuous stretches of railroad of considerable length.

To change a railroad from steam to electric operation requires not only a large expenditure of new capital, but also the abandonment and retirement of many existing facilities. Under conditions such as have existed during the last few years, and still exist, the additional capital for electrification would be difficult to arrange for and, in the case of many railroads, would be impossible. The wiping out of existing investments by retirements, although largely a matter of accounting, presents a practical difficulty of no small magnitude. As a practical matter, therefore, the electrification of steam railroads may be expected to be effected only on a showing of substantial benefits which would result in lowering transportation costs and leave the railroads a return somewhat more than sufficient to justify the increased financial burdens which the change would involve.

If made to include one or more operating divisions, electrification would most likely also include the urban terminals where the public benefits arising from it would be enjoyed. On the contrary, the electrification of large terminals only, brought about solely by local conditions, would not extend the benefits of electrification for the public beyond that immediate locality, and might prove to be an added burden rather than an economy for the railroad.

The preceding statements are presented as generalities and indicate some of the phases of the subject to which the committee will give careful consideration. The report is signed by C. F. Loweth, chairman; Bion J. Arnold, George Gibbs, George W. Kittredge, E. J. Pearson, Samuel Rea and Robert Ridgway.

Near Yale, B. C.

Basic Principles for the Electrical Workman

A Series of Articles Explaining Clearly the Reasons Underlying the Operation of Simple Circuits and Apparatus

By K. C. Graham

Part 2—Electro-Magnetism and Simple Circuits

WHEN a current flows in a conductor, little whirls or lines of force exist in the space surrounding the conductor, as shown in Fig. 8. These lines are exactly the same as those which emerge from a magnet. If a compass be brought near the wire it is influ-

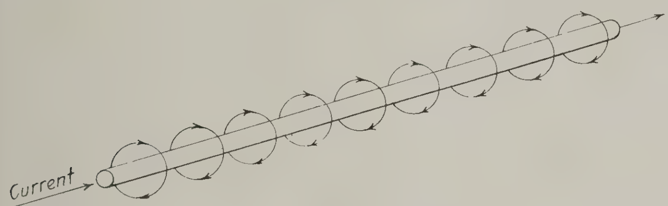


Fig. 8

enced by these magnetic lines. This is illustrated in Figs. 9A and 9B.

When the current is flowing in the direction indicated in Fig. 9A the north pole of a compass, placed over the wire, will be deflected toward the right, and if the compass be placed beneath the wire its north pole will be de-

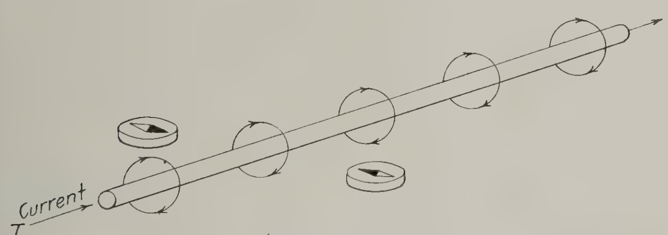


Fig. 9-A

flected toward the left. If the current flows in the opposite direction, as in Fig. 9B, the reverse of the above is true. It is readily seen, by reference to these figures, that the lines of force tend to deflect the north pole of the compass toward the direction in which they are moving.

An important point which should be noted from these

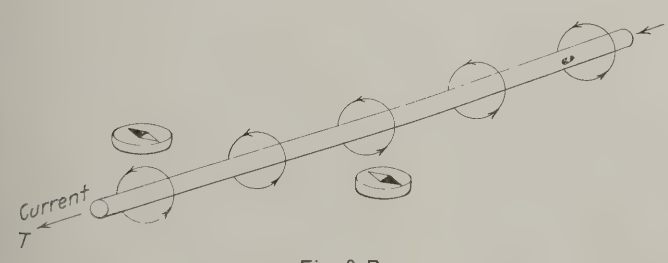


Fig. 9-B

figures is that if the current is flowing away from the observer, at T, the lines of force circle the conductor in the same direction as the hands of a clock, but if the current flows toward the observer, at T, the lines circle the wire in a direction opposite to that of the hands of a clock. This should be thoroughly understood because it enables us, with the aid of a compass, to determine the direction in which a current is flowing in a conductor.

Now, if the conductor be coiled up, as in Fig. 10, it exhibits all the properties of a magnet when a current is passed through the coil, that is, it has north and south poles and will attract pieces of iron which are presented to either end. The poles formed by the flow of current in the coil are readily determined by referring to the bolt and nut shown in Fig. 11. The direction in which the

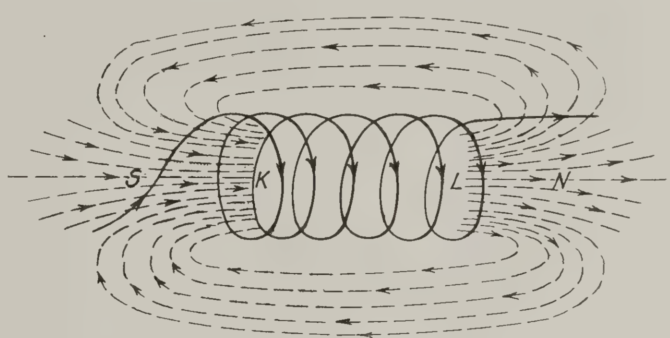


Fig. 10

nut is turned when the observer is facing the end of the bolt is the direction in which the current flows when the observer is facing the end of the coil, and the direction in which the nut moves along the bolt, that is, toward the head or away from the head, is the direction in which the lines of force move. For instance, when facing end K of the coil, if the current traverses the turns of the coil in the same direction as the hands of a clock, then the end K is the south pole of the coil, for if we turn the nut

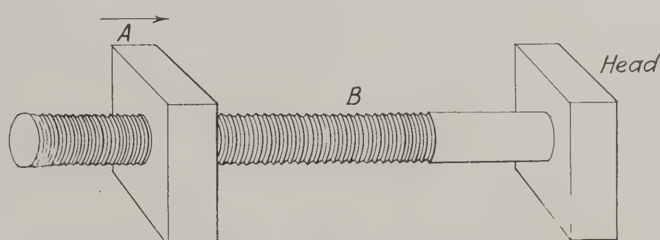


Fig. 11

in the same direction as the hands of a clock it will move toward the head of the bolt. This indicates that the lines of force flow inward at this point, that is, they enter this end of the coil, thus making end K the south pole of the coil.

If we face the end L of the coil the current is seen to be traversing the turns in a direction opposite to that of the hands of a clock. Therefore, referring to Fig 11, the nut still moves toward the head of the bolt. This shows

us that the lines leave the coil from the *L* end, thus making it the north pole of the coil. A coil of this kind is called a *solenoid*.

When magnetism flows through a piece of iron or through the air, or through any substance, in fact, it must overcome resistance, just the same as water must overcome the resistance in a pipe or current must overcome the resistance of a wire. The amount of resistance to be overcome depends on the substance, for instance, silver conducts electricity with greater ease than copper

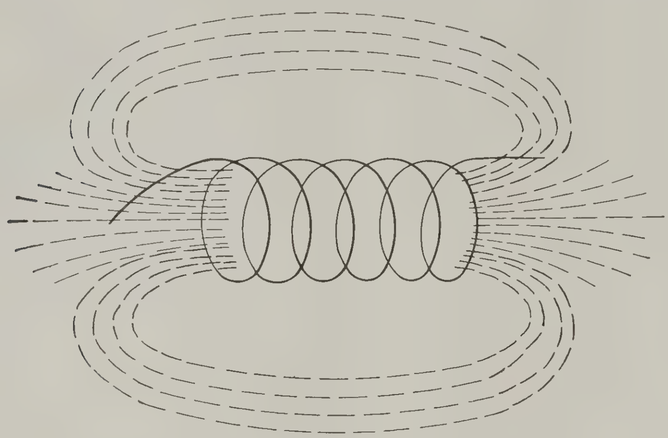


Fig. 12

does, that is, it offers less resistance to the passage of current. Therefore, silver is said to have less resistance than copper, copper less than iron, iron less than nickel, and so on. This may be explained by considering silver as a pipe without any kinks in it, copper as a pipe with a few kinks in it, iron as a pipe with more kinks, and so on. The pipe without kinks will of course offer less resistance to the flow of water than a pipe with kinks in it, or to put it in another way, the fewer the kinks, the lower will be the resistance.

Now this fact applies not only to the flow of current, but also to the flow of magnetism. Air conducts magnetism less readily than iron; therefore if we place a piece of iron within the solenoid, as in Fig. 13, the magnetism of the solenoid will appear much stronger than it was without the piece of iron or *core,* as it is called. This may be explained in the following manner:

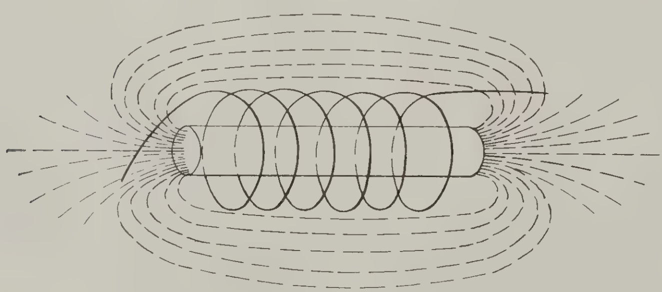


Fig. 13

Referring to Fig. 12, which shows the solenoid without the iron core, it is seen that the lines are widely distributed, while in Fig. 13, which shows the solenoid with the core in place, the lines are concentrated or brought together. This concentration is due to the fact that the lines tend to follow the path of least resistance, that is, if there is a choice between a path composed of iron and one composed of air the lines will tend to follow the iron path rather than the air path because of the lower magnetic resistance of the iron.

If we had used a copper core instead of an iron one, the coil would not have been made stronger by the application of the copper core because the magnetic resistance of the copper is practically the same as that of air.

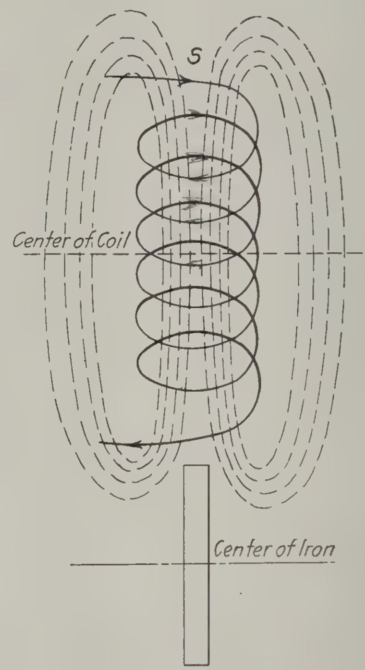


Fig. 14

The magnetic metals offer less resistance to the passage of magnetism than do non-magnetic metals or substances and this fact has been utilized in effecting a combination of a solenoid and magnetic core which is called an *electromagnet*. If a piece of iron be brought near the center of a solenoid (at the end) the iron will be drawn up into the solenoid until it has centered itself. After this position has been reached the iron will not be drawn up fur-

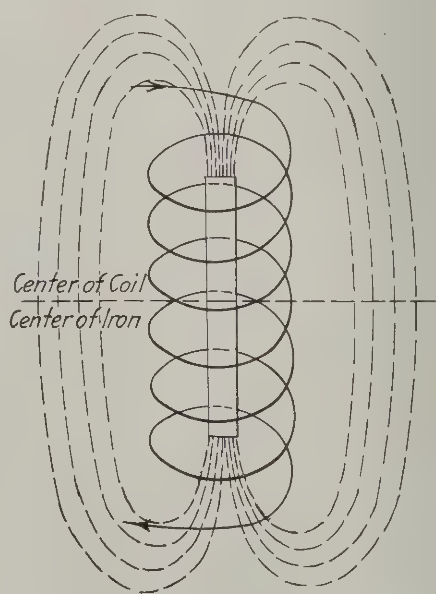


Fig. 15

ther, even though the strength of the solenoid be increased indefinitely. This is shown in Figs. 14 and 15, and is due to the fact that the lines tend to make their path as easy as possible. It is readily seen that this is the case when the center of the core is at the center of the coil.

Some Applications of Electro-Magnets

We shall now apply the knowledge we have gained to some of the practical features of our work.

Fig. 16 shows an electric bell connected in circuit with

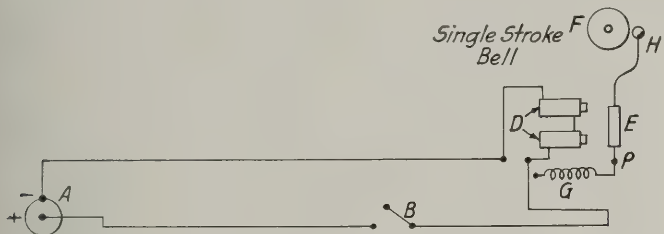


Fig. 16

battery A and push button B. In Fig. 16 the circuit is not complete because it is still open (not closed) at B, but when B is pressed the following results take place: Current flows from negative (—) battery through the solution to positive (+) battery, then through the wires

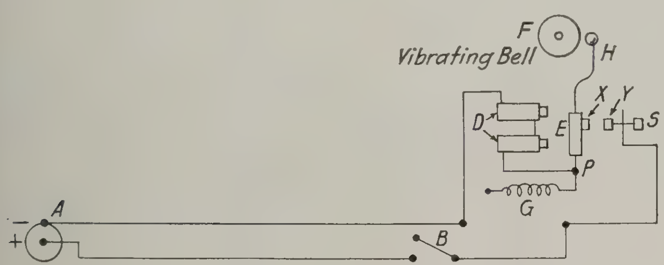


Fig. 17

and push button B to magnet coils D and thence to (—) battery completing the circuit. Now, the current in the coils D causes these coils to become magnets and, consequently, to attract the iron E which is attached to hammer H, thus ringing bell F. It should be noted that E is pivoted at P and normally held away from magnets D

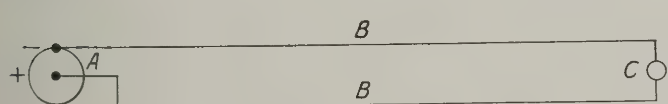


Fig. 18

by the action of spring G. The iron piece E is called the *armature* of magnets D. Of course, the use of the word armature in this case is entirely different from its use in connection with generators and motors.

It should be noted that armature E is held by magnets

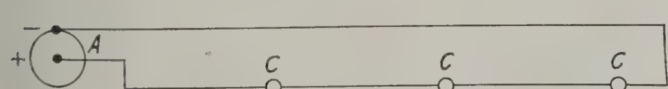


Fig. 19

D as long as current flows in the magnets, that is, as long as button B is pressed. This type of bell is known as a single stroke bell.

Fig. 17 represents a vibrating bell, that is, one in which the hammer rapidly vibrates back and forth at a rate of several times per second as long as button B is depressed. The manner in which this is accomplished is very readily explained as follows: X is a platinum contact piece con-

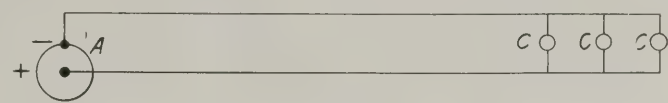


Fig. 20

tained in armature E and Y is a platinum point on screw S. X is normally in contact with Y, thus completing the following circuit: — battery to + battery, to push button B, to contact screw S, to contact point Y, to contact X, through E to D D, to — battery. Now, when current

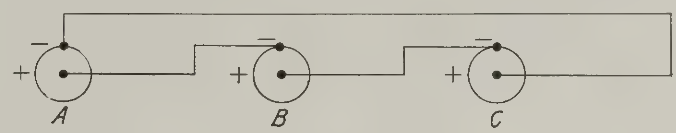


Fig. 21

flows through D D, E is attracted, thus breaking the circuit at X Y, causing D D to lose its magnetism and the spring G to pull E back to its former position, again causing X and Y to make contact and, therefore, to repeat the

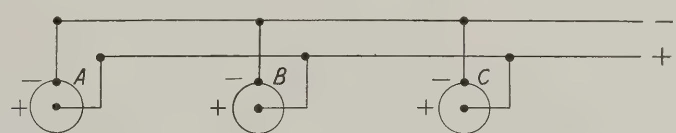
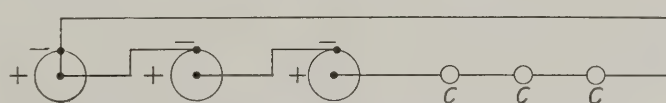


Fig. 22

cycle of operation. As this takes place rapidly H vibrates back and forth, ringing bell F.

Simple Circuit Connections

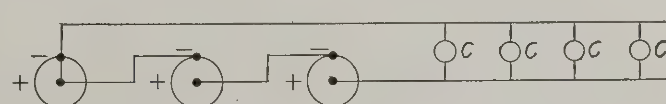
Fig. 17 shows the form of battery with which we are probably best acquainted, that is, the "dry" cell. The



Batteries in Series and Lamps in Series

Fig. 23

"dry" cell is only really dry in appearance because it is essentially the simple wet cell with which we have dealt throughout this discussion. The plates are zinc and carbon and the electrolyte is an acid, the acid being contained in some absorbative substance such as blotting paper.



Batteries in Series and Lamps in Parallel

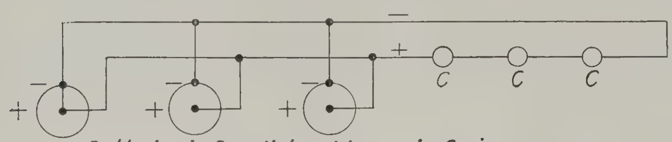
Fig. 24

Fig. 18 shows a simple light circuit consisting of a battery A, connecting wires B B, and a lamp C. The path of the current is easily traced.

Fig. 19 shows three lamps connected in series, that is, they are connected in such a way that the current which

flows in any one lamp flows in all three of the lamps so that if one of the lamps is removed the circuit is opened at that point and current ceases to flow.

Fig. 20 shows three lamps connected in parallel, that is, they are connected in such a way that the current in each

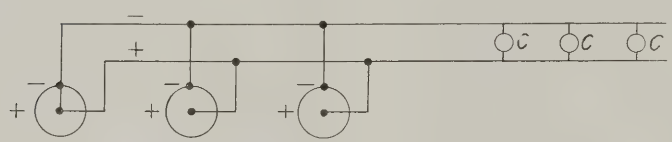


Batteries in Parallel and Lamps in Series

Fig. 25

one is independent of that in any other, and if one of the lamps is removed the others still continue to burn because their circuits have not been interfered with. The difference between the parallel and the series circuit must be thoroughly understood before we proceed to the next step.

Batteries may be connected in series and parallel as



Batteries in Parallel and Lamps in Parallel

Fig. 26

shown in Figs. 21 and 22. Fig. 21 shows three batteries, *A, B* and *C*, connected in series. Note carefully that in connecting batteries in series we connect + of one battery to — of the next battery. Fig. 22 shows three batteries connected in parallel. Note, in this case, that when connecting batteries in parallel, all the negatives are connected to one wire and all the positives to the other.

Figs. 23, 24, 25 and 26 show these two forms of connections as used with lamps or other apparatus.

Plans have been formulated for the electrification of Palestine by raising the level of the Sea of Galilee and harnessing the historic River Jordan, involving an initial expenditure of $10,000,000. The same project calls for the canalization of the Jordan Valley from the Sea of Galilee to the Dead Sea, where, under irrigation, it is expected that copious crops of dates, rice, sugar cane, flax and cotton can be produced. Provision for 2,000 miles of motor highways, commercialization of the Bagdad-Cairo air route, traversing Syria, and agricultural credit banks are among the other innovations contemplated in the modernization of the Holy Land. With a population of only 700,000, Palestine already imports $20,000,000 worth of commodities a year, and serves as a trading base for a population of more than 3,000,000 people in Asia Minor. Imports from the United States into Palestine have grown from an insignificant value of $291,990 in 1913 to $1,990,504 in 1921, and this region is bound to become an important market for American wares as the population and industrial development of the country increases. Clothing and textile piece goods, coffee, flour, furniture, gasoline and kerosene, metal manufactures, machinery, motor cars and accessories, rubber goods, shoes and boots, figure among the imports from the United States, with a growing demand especially for cotton piece goods and for petroleum products, about 90 per cent of which now come from America.

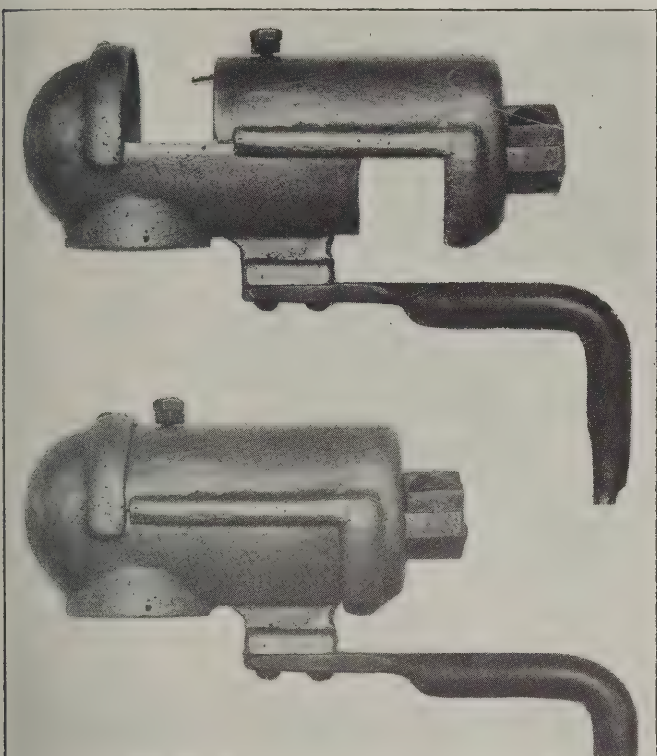
Where the Canadian Pacific Follows the Fraser River at Yale, B. C.

Six-Volt Lighting in Locomotive Cabs

An Interesting Experiment Tried on the Michigan Central In Order to Reduce the Size of Gage Lamp Fixtures

A UNIQUE and interesting feature in connection with locomotive lighting is being tried out on the Michigan Central by using a six-volt lighting system in the cab, the main object sought being that of making it possible to use smaller lamps and fixtures for the various gages to be lighted.

The amount of light derived from the 32-volt standard cab lamp is considerably more than is required for illuminating the gages and by using smaller lamps a material reduction may be made in the size of the fixture, which is important from the standpoint of the workman who has work to perform in the cab, as well as from the standpoint of the enginemen, on account of lessening the obstruction to a clear view of the gages from the various positions in the cab.



Photographs Showing Method of Opening Fixtures and Means of Supporting Them Over the Various Gages

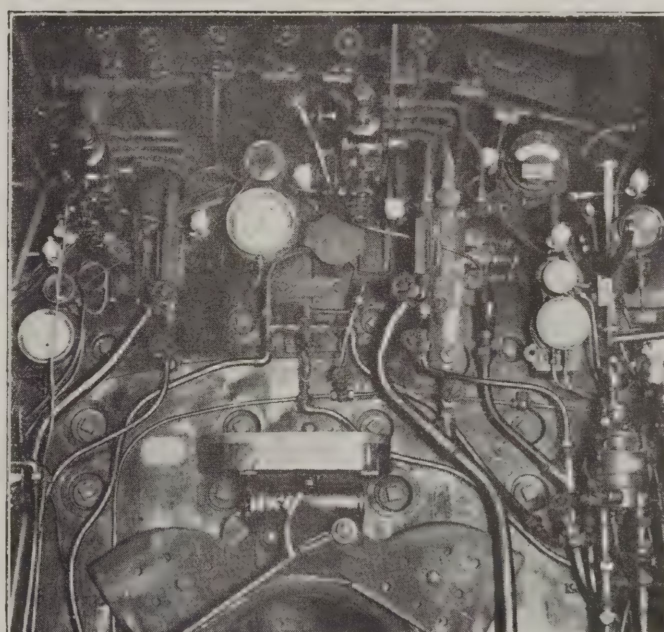
The mechanical department of the road felt that smaller fixtures could be satisfactorily substituted for the larger ones and set about to design such a fixture. Naturally enough the smaller fixtures required a smaller lamp.

Thirty-two volt lamps, smaller in size than those commonly used in locomotive cabs at present, have not been developed. The reason for this is that such lamps would necessarily require a higher resistance. While this increase in resistance could be met by using a finer and more fragile filament, it was believed that the excessive vibration of the locomotive would make the design of such lamps impracticable—at least at the present stage of the lighting art.

Apparently the only way to secure a smaller lamp and at the same time retain a rugged filament was to use 6-volt lamps, and this is what the Michigan Central has done on its experimental installation on a new design of locomotive which was recently received and which is equipped with practically every improvement that can profitably be applied to a steam locomotive. Therefore, on account of the additional lighting required in the cab, it was of particular advantage to utilize gage lighting fixtures as small as possible.

The lamps which have been adopted for this experimental low voltage operation are standard 6 to 8-volt 21-candle power automobile headlight lamps except that they are equipped with the No. 100 or standard Edison screw base. In this particular installation there are ten of these 6-volt lamps used. Seven are used for illuminating gages, one for the lubricator, one over the engineman's seat and another over the fireman's deck.

The present installation perhaps should not be considered final, for while the gage lamps give more light than is needed, there is reason to believe that lamps of larger candle power will be required for the enginemen and firemen. This of course is a detail which may be taken care of by using larger 6-volt lamps for these two locations.



View of Cab Interior Showing the Location of Seven of the Six-Volt Fixtures Illuminating the Gages

It may easily develop that even smaller lamps can be used for the gages, which will reduce the required current to such an extent that larger lamps can be used for the enginemen and firemen without producing too heavy a load on the 6-volt circuit. It is estimated that the load

produced by the ten 6-volt 21-candle power lamps in the present installation is approximately 200 watts.

The Low Voltage Source

The locomotive in question is equipped with an alternating current turbo-generator of the inductor alternator type and when running at normal speed of 5,000 revolutions per minute, has a frequency of 750 cycles. The frequency of the machine, however, is not an important factor, but is rather an incidental result of the speed required to develop the 32-volt alternating current energy.

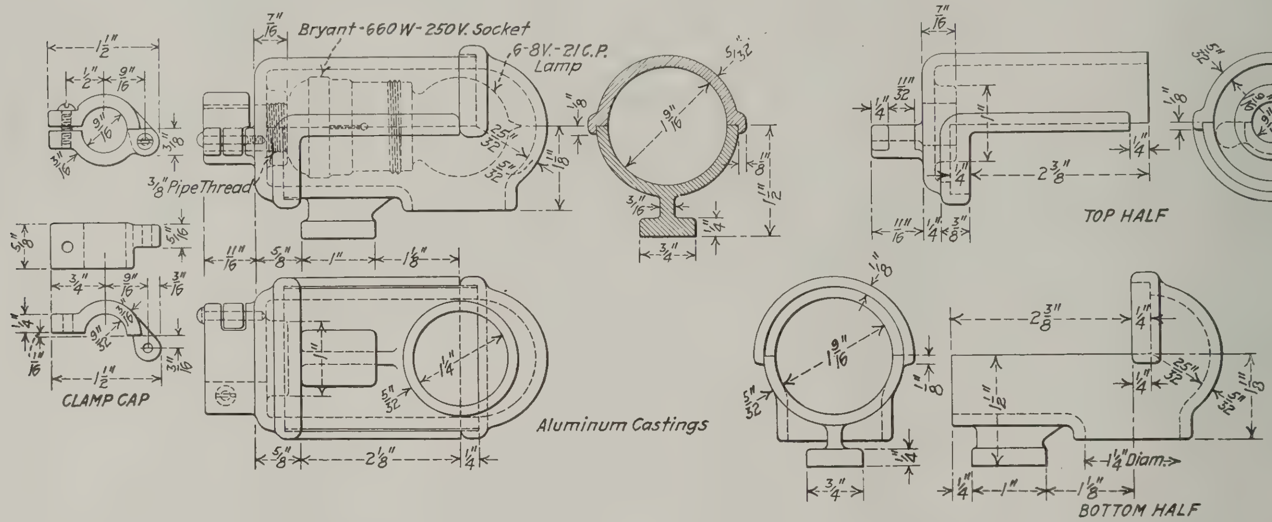
The machine has no brushes or no rotating wires. The electro-motive force is developed in a stationary coil consisting of relatively few turns of No. 8 wire, this coil being so placed that it is cut by rapidly changing magnetic flux, as the rotating soft iron element revolves at high speed between the poles of powerful permanent magnets.

As 32 volts are available at the terminals of this coil, it is comparatively a simple matter to tap the coil windings at any desired point. This was done so that a voltage of 5½ was secured, the half-volt difference between lamps and circuit being allowed to increase the life of the lamps. Even at this voltage the lamps give plenty of light with the possible exception of the engineman's and fireman's lamps.

The turbo-generator is capable of starting and carrying its rated load of 500 watts at 60-lb. steam pressure. Its voltage regulation does not exceed 2½ volts at the 32-volt terminals while its speed regulation is within one per cent.

In passing, it may be said that a similar experiment with 6-volt cab light operation has been tried on another road but with a direct current machine. Six-volt d. c. cannot be practically secured from the d. c. turbo generator now in service by the use of a third brush, as the armatures are not designed to carry the current which would flow. This experiment was successfully accomplished, however, by taking taps from the armature windings to collect rings and thence to a step down transformer from which the desired 6 volts were satisfactorily obtained.

To just what extent 6-volt cab light operation may be carried would be difficult to say, but it is easy to concede that it has certain advantages, particularly in reducing the size of fixtures.



Detail Sketches Showing Construction and Dimensions of Six-Volt Gage Lighting Fixture

Santa Fe Locomotive with 79 Cars on Boston & Maine

Practical Points in Railroad Shop Welding

Practice on D. L. & W. Includes Extensive Reclamation Work—Tobin Bronze Used in Welding Cast Iron

By E. S. Eldridge

Welding Foreman, D., L. & W. R. R. Shops, Kingsland, N. J.

IN making a frame weld with an electric arc, the first step is to strip the frame so as to give the welders plenty of room to work. After this has been done, expand the frame from 1/16 to ⅛ in. and then cut or burn out the ends of the opening to about a 60-deg. "V" on both sides of the frame. In case the metal has been

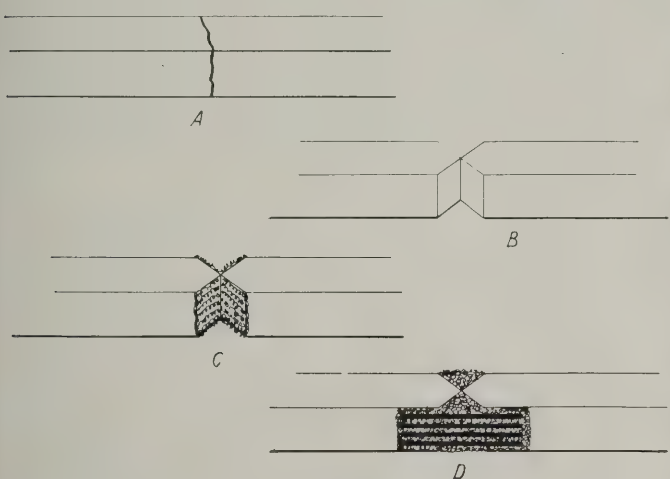


Fig. 1—Various Steps in Welding a Broken Frame by the Electric Arc Process

burned out, all scale should be very carefully chipped off in order to get a good clean surface to work upon. Sketches A and B in Fig. 1 illustrate these preparatory stages. After the work has been prepared, the weld is begun at the center, and then continued from edge to edge as shown in sketch C of Fig. 1. By performing the work in

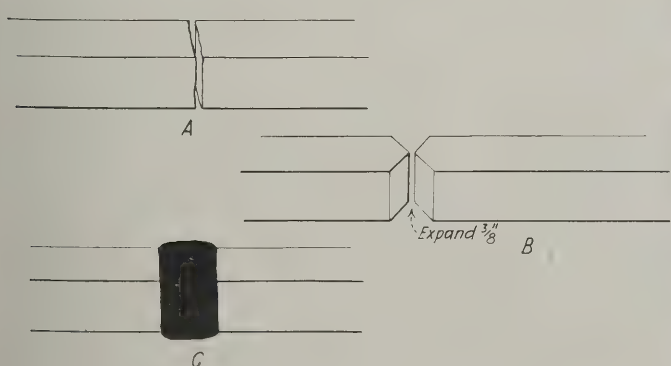


Fig. 2—Stages in Frame Welding by Gas Torch

this way, the same contraction is secured on the last layer as on the first. And the weld has been brought up flush with the sides of the frame, the outer edges are reinforced with ⅝ or ¾-in. round bars of mild steel, 8 in. long and the spaces between the bars are filled in to give the necessary strength. A drawing of such a completed weld is shown in sketch D of Fig. 1, and a photograph of such a job is shown in Fig. 3.

For acetylene welding the engine frame is prepared in the same way as for electric welding except that the expansion is made ⅜ in., which is a little larger than that

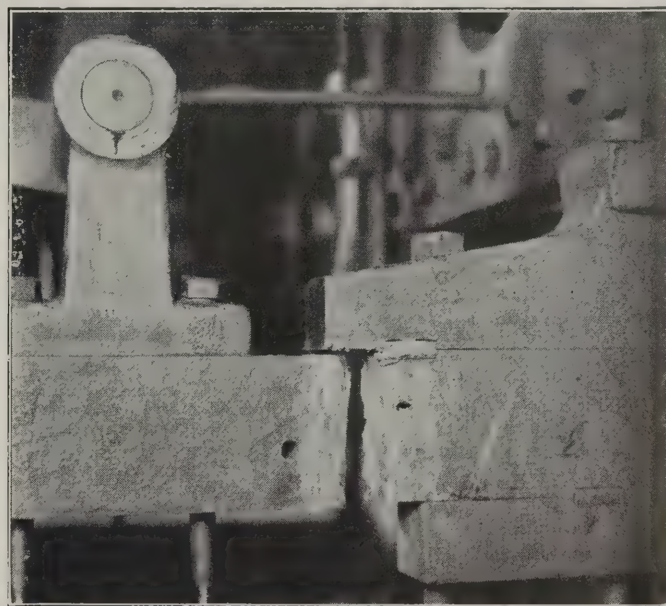


Fig. 3—Broken Frame Prepared for Electric Welding

required when the electric arc is used. The actual welding is usually performed by two operators, one on each

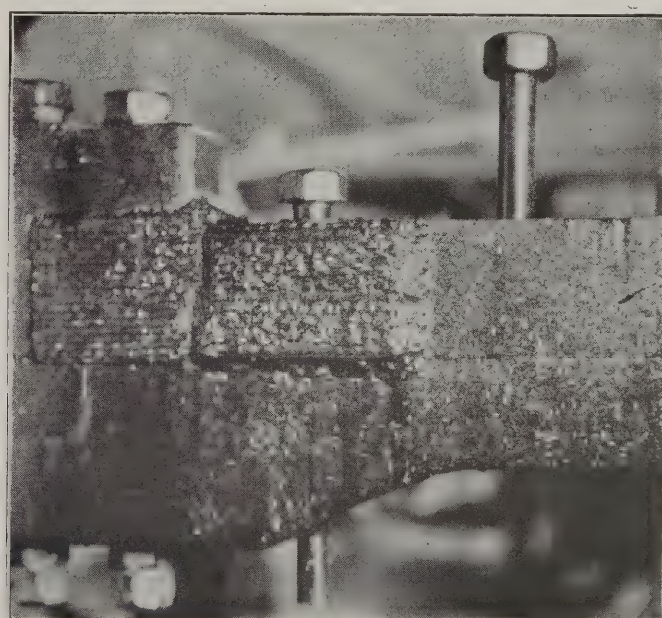


Fig. 4—Electrically Welded Frame

side of the break. The frame is brought up to a yellow heat in the vicinity of the weld before the rod is applied.

The weld is begun at the bottom of the "V" where a matted state is first produced. Each succeeding layer of material reinforces the previous layer about 25 per cent. After the weld is made, the jacks and wedges are taken

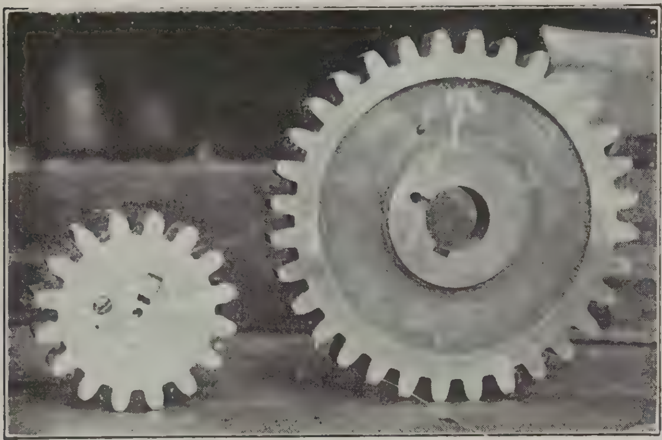


Fig. 5—Gears Repaired With Tobin Bronze

out and the metal allowed to cool off. When the cooling is completed, it will be found that the frame has come back to the same position it occupied before it was

Fig. 6—Pile of Eccentric Cams Repaired With Tobin Bronze

broken. The various stages of gas welding work may be seen in the several sketches of Fig. 2. Photographs of this work are shown in Figs. 3 and 4.

Broken cast iron gears can be readily repaired by substituting Tobin bronze for the missing metal parts. So far it has only been practical to use Tobin bronze in connection with gas welding. In repairing broken teeth the metal is chipped out to a depth of about 1/16 in. below

Fig. 7—Broken Cylinder Repaired With Tobin Bronze

the root of the tooth. Heat is then applied until the Tobin bronze flows freely. This temperature is slightly below the melting point of the cast iron. The Tobin bronze is spaded over the surface to obtain a tinning

Fig. 8—Preparations for a Fire Box Patch

effect which is easily secured when the metal is at the right temperature. If the bronze is too hot, it will not take hold or bite into the cast iron, and if it is too cold, it will roll off in a ball. When the temperature is correct, however, the Tobin bronze will flow like water. After the gears have been built up in this way, the bronze teeth will stand more strain than the cast iron teeth. There

have been instances where the cast iron teeth have broken out of a brazed gear and the bronze teeth, while bent over, still held as firmly to the body of the gear as when first put on. A sample of gear repairing may be seen in Fig. 5.

In building up cast iron or brass cams or cam straps to take up side play, the Tobin bronze is put on the same as for gears. By brazing the cams and strap in this way about 15 hours of machine work is saved on each cam and cam strap and at the same time there is secured a set which is as good as new. A pile of eccentric cams is shown in Fig. 6. In the brazing of piston heads, it is first necessary to turn them down about 1/32 of an in. in order to get below the glazed metal. After this has been done, they can be built up to any size desired. In the process of brazing piston heads, the bronze and cast iron are worked together with the result that the mixture of metal will wear longer and will not cut the walls of the cylinder. A sample of cylinder welding with Tobin bronze is shown in Fig. 7.

In welding firebox sheets with the electric arc both the old and new sheets are chipped to an angle of 45 deg.

Fig. 9—Two Driving Wheel Spokes Repaired by the Electric Arc

and the sheets butted together, leaving an opening from 1/16 to 1/8 in. The sheets are then tacked together about every 6 in. in order to hold them in place, after which the welding is begun. The first layer is placed in the opening and the remainder of the "V" filled up and reinforced, always using the cross welding. In welding patches in fireboxes, always cut round corners so as to get away from lock up stresses. The patch should also be dished about 1/4 in. Tack the patch at intervals of 6 in. except at the bottom. The work should alternate, first welding about 6 in. on one end and then 6 in. on the other until the top of the patch is reached. The top seam is then welded, the bottom being left until last. In welding the bottom seam, first tack it as before. By welding the bottom seam last, the heat will travel up through the patch. In this way when contraction takes place and the patch straightens out, the heat of the bottom weld will soften the patch and take away all of the strain. Preparations for a firebox patch is shown in Fig. 8.

Another interesting application of electric arc welding is found in the welding of spokes to engine wheel. Fig. 9 shows this type of weld. In this work the spokes are "V'd" out to about 45 deg. and all scale chipped off one inch back of the weld. The tire is then heated with th tire heater until the broken spokes open up about 1/8 ir after which the weld is made in the usual manner, r inforcing about 1/8 to 1/4 in. all the way round the spok so that when the wheel is cooled off it will come back where it was in the first place. Trying to weld spoke without heating the wheel will result in a flat spot in th rim and cause either the weld to break or the spokes break in another place.

Lifting Magnets—Limitations and Possibilities

During the war there arose proposals that ships equipped with huge magnets which, when energiz would draw submarines to them where, being he less, they could be destroyed. In peace times equally i possible proposals are made with respect to magnets. Su propositions overlook the fact that while magnetism n be detected through long distances by means of delic instruments as, for instance, the earth's magnetism by compass, yet drawing power in large, usable, effect quantity can only be exerted through short distances to 12 or at the most 15 inches.

Where the magnet can come near or in contact with pull or its load it is wonderfully effective as proved by universal use in steel mills, blast furnaces, foundri forge plants, scrap yards, railroad yards and other pla where iron or steel in quantities must be handled. many such situations a magnet will save its own cost three to ten months' time.

In Fig. 1 are shown two super-rectangular magne

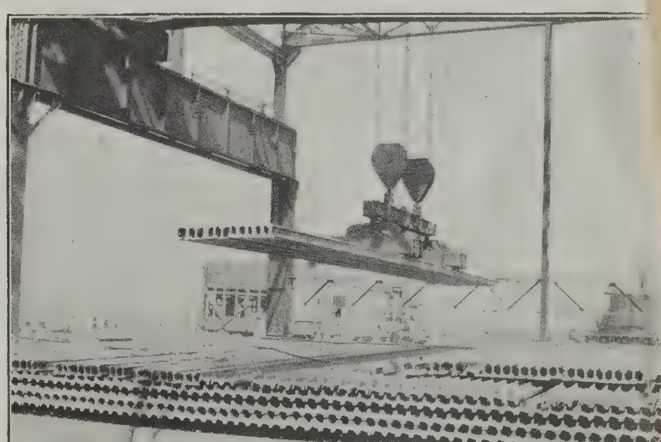
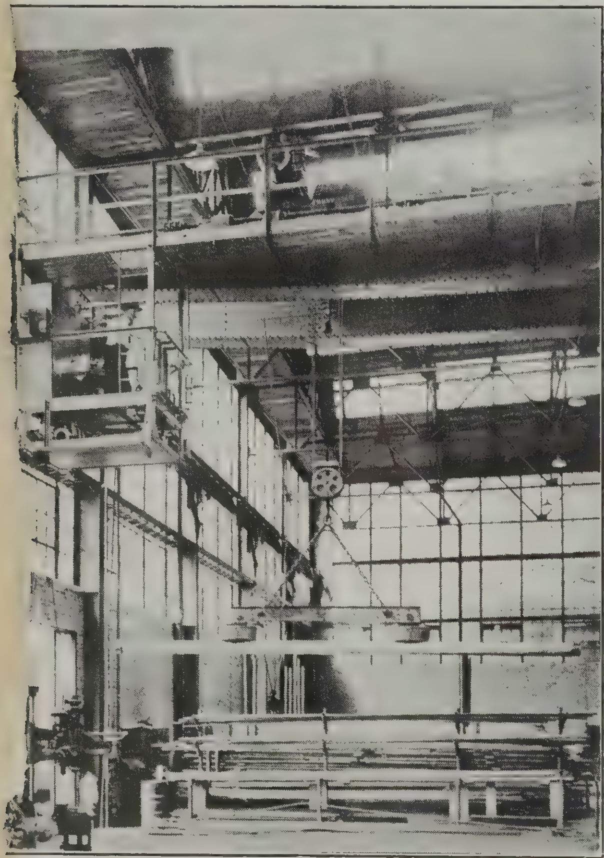


Fig. 1—Two Lifting Magnets Mounted on a Beam Can Be Used to Carry a Load of Thirteen, 40-Ft., 90-Lb. Rails

mounted on a beam and controlled in parallel by the operator in the crane cab. These magnets are two of nine used by the rail mill of the Inland Steel Company at Indiana Harbor, Ind., to handle and load its product. The load shown consists of thirteen 90-lb. rails, each 40 ft. long, the total weight of the rails being 15,600 lbs. These magnets require little head room, are strong mechanically and are highly efficient. They will lift 17 or 18 such rails if stacked in double locked layers.

Fig. 2, shows two 20-in. round magnets on a beam

olled in parallel by the operator in the crane cab and in the Kelly-Jones, Chicago, warehouse to store afterward to reload, on delivery wagons, pipe from the lest to the largest sizes. The system is effective and



. 2—A Pair of Lifting Magnets Used for Handling Pipe

a lot of time and space. The Crane Company's pipe ehouse in Pittsburgh has a similar equipment.

Iost magnets are used for loading or unloading iron steel materials, but there are many related uses not so common or well known but equally interesting and important economically. One of these latter cases is quoted below.

Fig. 3 shows a magnet about 40 in. in diameter and having an energizing coil wound for continuous service supported above a belt conveyor carrying silver ore at the Fresnillo, Mexico plant of the Mexican Corporation, S. A.

The object of this installation is to extract stray or tramp iron or steel from the ore as it passes under the magnets. If such pieces are not taken out they will break the crushing rolls causing great delay and expense. Small

Fig. 3—A 40-In. Magnet Used to Extract Iron from Silver Ore

magnets have been in use for this purpose in flour mills for many years, but in late years many large ones, such as that shown, have been used over belt conveyors of copper and lead ores, also coal and other materials to save the crushing of machinery and in some cases also to prevent the admixture of iron with the product.

There are many other useful and interesting special magnet applications, but always the limitations noted in the first paragraph must be remembered. The lifting magnets illustrated were built by the Ohio Electric and Controller Company, Cleveland, Ohio.

A Typical Australian Suburban Station With Car-Floor Level Platforms

Economy of Cutting Metals With the Electric Arc

Arc Process By Far the Cheapest Method For Cutting Rivets or For Cutting Steel Plate Into Small Size

By A. M. Candy
General Engineering Department, Westinghouse Electric & Mfg. Co.

THE process of arc cutting is purely a melting process, the heat and energy of the arc terminal being directed along the line where the cut is desired. Graphite or carbon electrodes are usually employed for this work although bare metallic electrodes have been used by operating them at current values in excess of those used for welding. This latter scheme is not economical and, therefore, will not be discussed. In special cases metallic electrodes heavily wrapped with asbestos yarn using current values higher than normal have been used for cutting, the electrodes being first dipped in water, which forms steam and blows the molten metal away. This method, however, is also very expensive and has been used only to a limited extent by the British Admiralty for cutting deep, small diameter holes in armor plate.

For general cutting work graphite or carbon electrodes are used and current values of 300 to 1,000 amperes, depending upon the nature of the work and the cutting speed desired.

Foundries make use of arc welding equipment for repairing defective castings and use the same apparatus for cutting off risers and burrs from their castings. Fig. 1 shows a riser from a large grey iron casting which was cut through the neck in 5 minutes' time using 800 amperes, the neck measures 3 in. by 9 in. Just as a demonstration the riser was then cut through the main portion, 8 in. by 8 in. in 17 minutes by using 800 amperes. With labor at 60 cents an hour, and electric power at 2 cents a kilowatt-hour for the motor-generator, we have a cost of 15 cents for cutting neck and 52 cents for cutting body of the riser.

Fig. 1—This Riser from a Large Grey Iron Casting Was Cut Through in Five Minutes Using 800 Amperes

Fig. 2 shows two sample cuts. The one above, which is cast iron 1½ inches thick, was cut at a rate of 16½ feet per hour and the one at right, steel one inch thick, was cut at a rate of 21½ feet per hour, both cuts made using 400 amperes.

Where it is desirable to cut the material to accurate dimensions, it is necessary to lay out a guide line with white lumber crayon which the operator can follow with his arc. It is then possible to make a neat cut in ¼, ⅜ or ½ inch thick plate steel as illustrated by Fig. 3. This shows a piece of ¼-inch plate steel cut at rate of 75 feet per hour using 450 amperes.

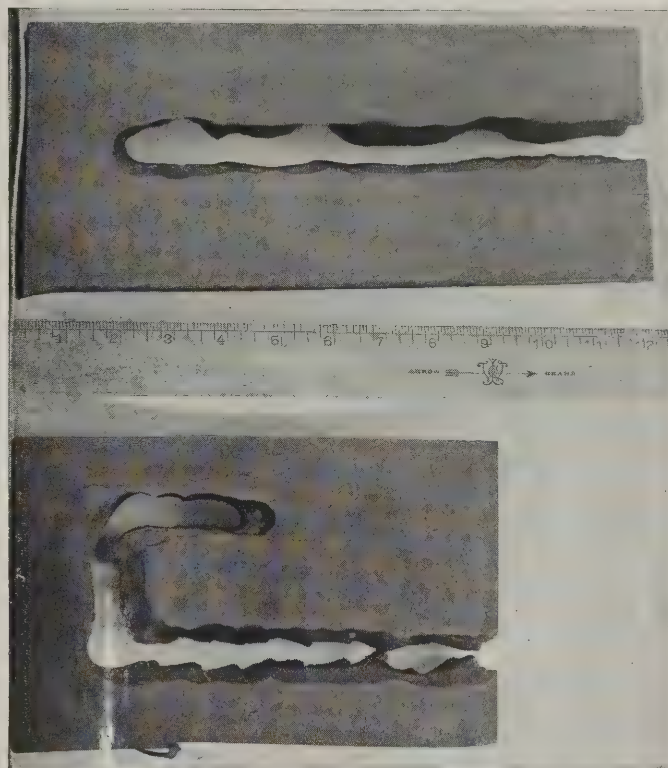


Fig. 2—Two Cuts Made Using 400 Amperes. The Upper Illustration is Cast Iron 1½ Inches Thick and the Cut Was Made at the Rate of 16½ feet per Hour. The Lower Sample is of Steel 1 Inch Thick and Was Cut at the Rate of 21½ Feet per Hour.

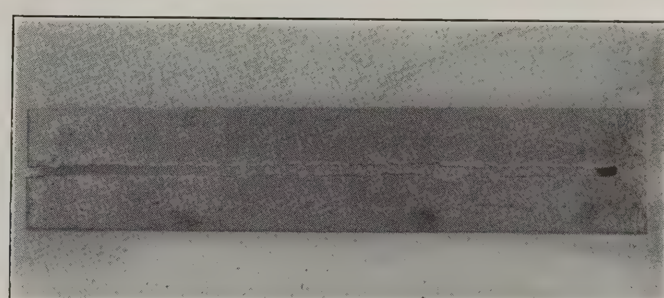


Fig. 3—It Is Possible to Make a Neat Cut in Steel Plate With the Electric Arc. The Above Illustration Shows a Piece of ¼-Inch Plate Steel Which Was Cut at the Rate of 75 Feet per Hour.

Fig. 4 shows a sample of riveted plate, some of the rivets having been cut off with the arc. Companies making a practice of scrapping and rebuilding steel freight

cars will find the arc process by far the cheapest method for cutting rivets and for cutting up steel plate material into pieces sufficiently small either to be charged directly into the cupola or to be cut up to such size that the pieces may be handled for recutting in a shear. The plate material in these cases is generally heavily covered with paint or rust, so that current values of 400 to 600 amperes are frequently used, and, in some instances, as much as 800 amperes. Using this latter current value cars have

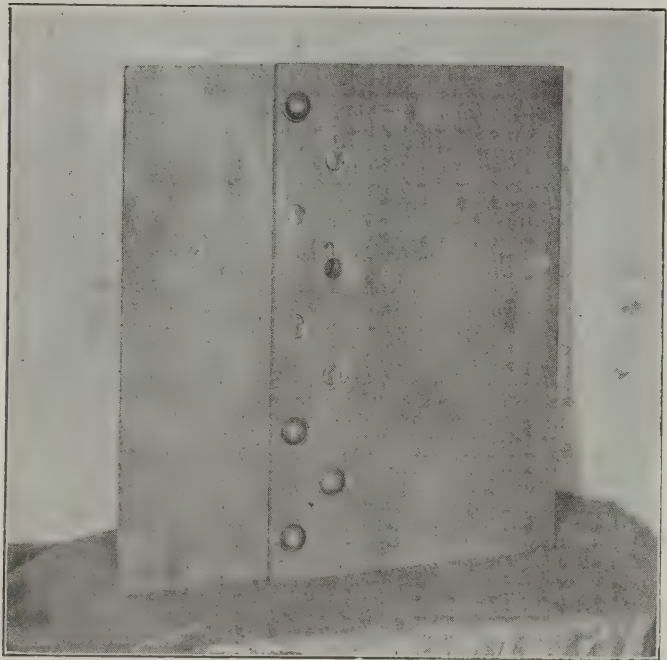


Fig. 4—A Sample of Riveted Plate Showing Some of the Rivet Heads Cut Off With the Electric Arc

been cut up at an average rate of 75 feet per hour, an entire coal car being cut up in four hours' time into pieces sufficiently small to be handled by four men who were shearing the material for cutting into charging size. The cost of the arc cutting, including labor and power for the motor-generator was $6.80.

For cutting the rivets, currents of 400 to 600 amperes

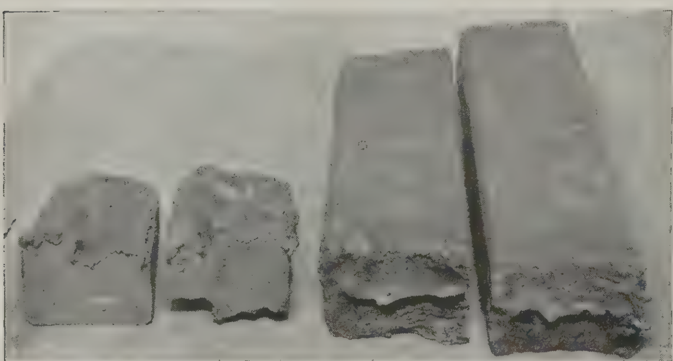


Fig. 5—Two Copper Billets Cut in Two With the Electric Arc

are usually used. When using 400 amperes, average operators will cut from 1,800 to 2,000 rivets, 5/8 inch in diameter, per ten-hour day and some operators will run as high as 2,600 to 3,100 such rivets when the work is on a piece-rate basis.

Cutting with the arc is not limited to iron and steel, but can be applied equally well to non-ferrous metals, such as brass, bronze and copper. In fact, for cutting copper which cannot be cut mechanically the arc process is by far the cheapest to use.

Because of the high thermal capacity and high heat conductivity of copper, it is necessary to concentrate the applied heat at a sufficiently high rate to melt the copper before the heat is dissipated in it. To do this cutting effectively it has been found most satisfactory to use a current value of 800 to 1,000 amperes. Fig. 5 shows two copper billets 4 in. by 5 in., which were cut in two as indicated, using 950 amperes, the cutting time being 6½ minutes for one and 7 minutes for the other.

Fig. 6 (negative 131776) shows a large piece of copper

Fig. 6—Large Piece of Copper Slag 7 Feet Long and Having An Average Thickness of 4½ Inches Was Cut in Two in 5 Hours by the Electric Arc.

slag which was originally 6½ feet wide and 7 feet long along the central cut. The metal was approximately 1½ inches thick through the sections where the side cuts were made. This was done at a rate of 3½ feet per hour. The thickness of the metal through the central cut varied from about 1½ inches at the extreme edge to 7 inches at the center of the piece, the average thickness, therefore, being about 4¼ inches. This cut was completed in 5 hours. A current value of 1,000 amperes was used for all this work. The cost of doing the work on the basis of labor at 60 cents an hour and electric power for the motor-generator at three cents a kilowatt hour is $16.78.

From the data given in this article, it must be evident to those having experience with other methods of cutting that the arc process is much cheaper than any other, except mechanical cutting where shears are used.

The Village of Wassen on the St. Gotthard Line

Electrical Equipment of C. & N. W. Grain Elevator

Dust-Proof Distribution Panel Cabinets, Vapor Proof Lighting Units and All New Conduit and Wiring Ensures Reliable and Safe Operation

By Jos. Andreucetti
Assistant Electrical Engineer, Chicago & North Western RR., Chicago

WHEN rebuilding the Chicago & North Western grain elevator at Chicago, which was destroyed by a dust explosion on March 19, 1921, it was found necessary to renew a considerable portion of the electrical apparatus. The explosion wrecked a number of the motors, destroyed the electrical signaling system for the belts, and smashed the switchboard in the power house.

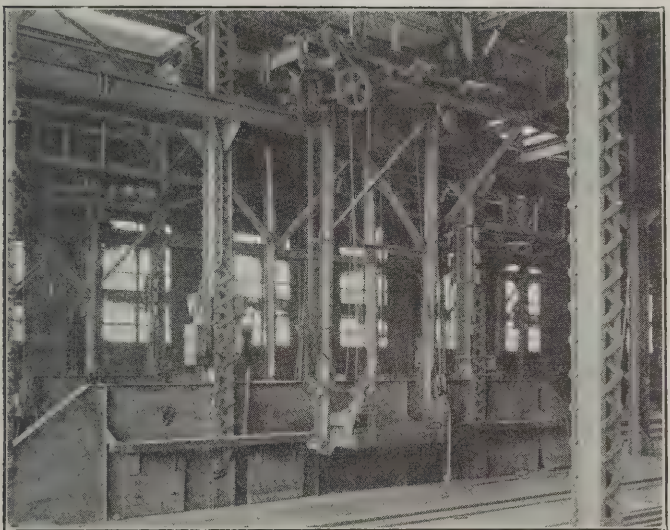


Fig. 1—Car Shed Showing Car Unloaders, Motor Compensators and Signal Lamps

Fig. 2—First Main Aisle of Work House on Left. Train Shed on Right. On Extreme Left Compensator Marked C is for One of the Fan Motors Above. The Set of Lights Marked S Is Used for Signaling From the Point at Which the Grain is Being Delivered to the Belt

In order to insure reliable results all the conduit and wiring was replaced, the motors were overhauled or replaced and the entire lighting system was hauled out and renewed. The signaling system was entirely rebuilt and the panel boards were constructed in dust proof rooms.

Largest Elevator in the World

In order to gain some idea of the size of this elevator it is stated that this is the largest grain elevator in the world, having a storage capacity of 10,000,000 millions bushels of grain. The grain may be received from the box cars at the rate of 375,000 bushels in 10 hours and can be shipped out at the rate of 250,000 bushels in 10 hours. As this elevator is located on the Calumet River connecting with Lake Michigan, the grain may be loaded and unloaded from the lake boats directly. On the marine leg, grain can be received from the boats at the rate of 20,000 bushels an hour and can be loaded into the boats from the river house grain storage at the rate of 120,000 bushels an hour.

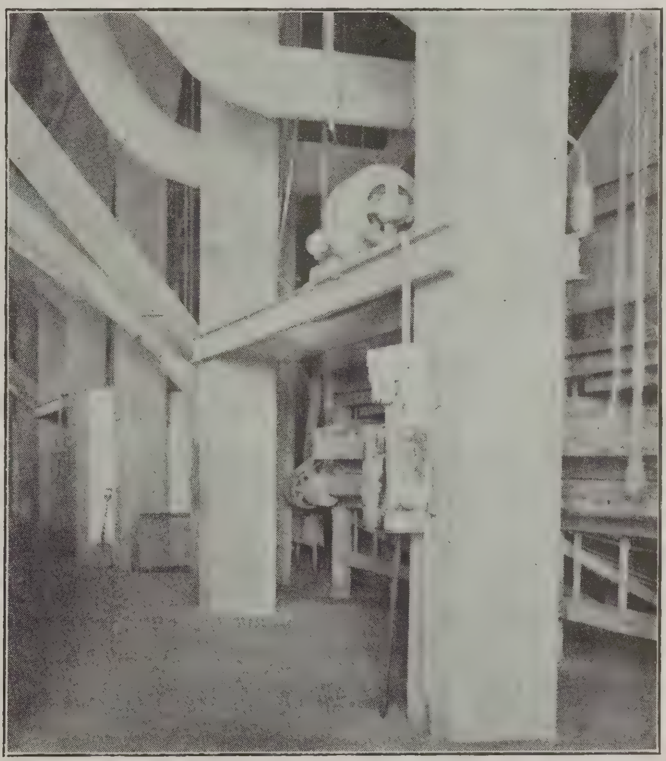


Fig. 3—One of the 25-H.P. Motors With Compensator Used to Drive the Dust Separators in the Work House

Electrical Apparatus Handles Grain Through the Elevator

The photograph Fig. 1, shows the train shed; the equipment shown being the car loading apparatus. This equipment can be run back and forth along the railing for a limited distance only, in order to stop the device in front of the car door. Large grain boards or scoops, shown leaning behind the rail are then hooked onto the

chain at the end of the rope. By co-operation with a man in the car and a man on the clutch lever, it is possible to pull the grain out of the car at a very rapid rate. As the grain falls out of the car door, it goes into a large hopper below the tracks and is conveyed by means of large belts operated by electric motors to the elevators that carry it to the scale floor, which is over the bins above the work house, from where it is dumped into one of the concrete bins over the work house. From these bins the grain is allowed to travel by gravity down to the work house in which portion of the building are located the cleaner fans, the oats hullers, etc. A view of this work house is shown in Fig. 2. This picture shows the first main aisle of the work house on the left, and looking to the right we see the interior of the car sheds. The grain coming down from the bins above this work house gravitate into the cleaners at the left of this picture, shown also in Fig. 3. On the extreme left of this view Fig. 2, is shown one of the compensators marked *C* for the operation of one of the 25 hp. motors that propels one of the fans for cleaning the grain. As soon as the grain passes through the

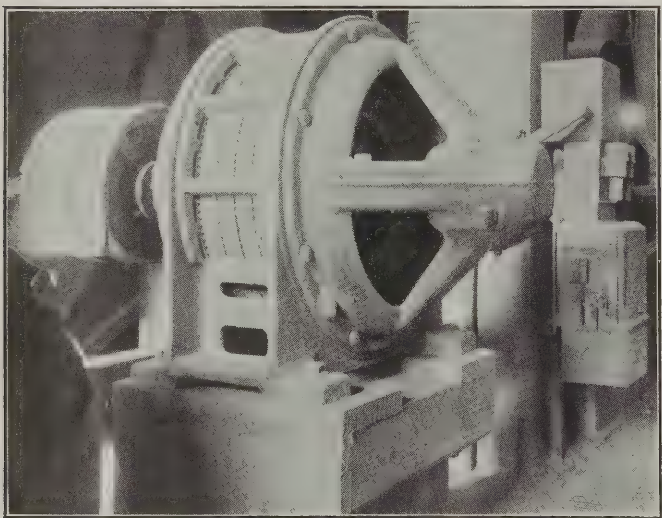


Fig. 4—A 60-H.P., 550-Volt, 3-Phase Motor and Compensator, Used to Drive One of the Oats Clippers in the Work House

several cleaning devices in the work house it passes on down to another belt which carries it through to another elevating device that deposits it in one of the larger storage bins where the grain remains until ready for shipment.

Electrical Signaling Equipment Controls Operation of Many Functions

An elaborate system of signals consisting of different colored lights with bells and horns is installed to facilitate communication between the men operating the grain elevators, belt conveyors, discharge chutes and tubes.

The loaded cars of grain are spotted in the car sheds before the grain unloaders by means of a cable operated from a cable cab in the center of the building. In this cable cab are several bells and horns which may be controlled from a number of switches located in different parts of the car shed. By means of these switches a man spotting the car can signal to the cable operator when to start and stop pulling.

A signaling system connects the track hopper outlet valve below the tracks with the location of the track hopper levers, marked *L* shown in Fig. 2. This system consists of an arrangement of amber, green, and ruby lights at both ends, the lamps being in series and electrically interlocked from switches at both ends.

The "track hopper valve" signal system connects the track hopper lever system, marked *L* in Fig. 2, with the

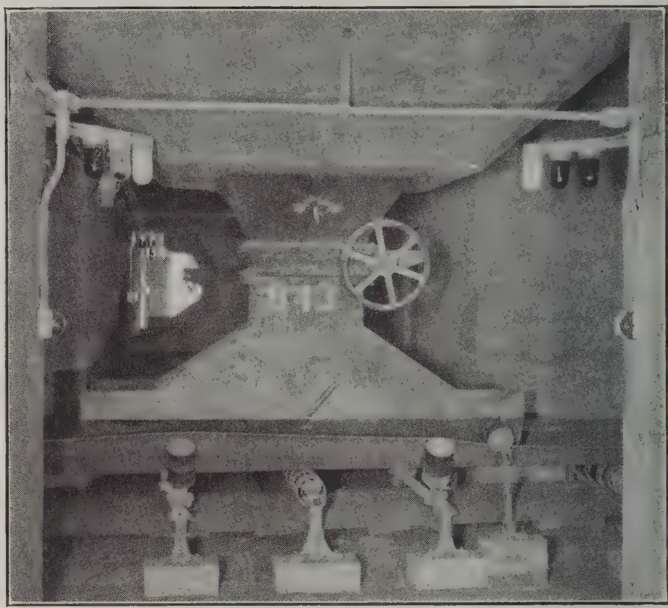


Fig. 5—View Showing Belts Carrying Grain at an Outlet Chute Under One of the Large Bins. One of the Three Lights is Used for Illumination. The Red Light Means that the Attendant Should Stop the Flow of Grain. The Green Light Indicates that Everything is All Right to Start the Flow of Grain Onto the Belt. In Case of Jam at This Point the Attendant Signals to the Work House By Means of the Switches on the Wall

receiving leg on the scale floor which is above the bins over the work house. Electric switches connected to the large levers shown in Fig. 2, close the circuit through

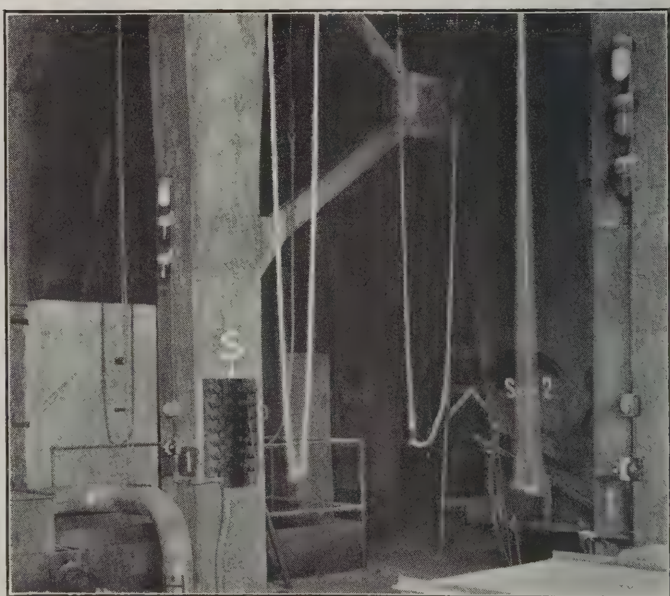


Fig. 6—Interior of Work House Showing Switches for Remote Control of Belt Motors

relays which are located above the bins on the scale floor. These in turn close circuits through the lamps, which are located on the scale floor and also the indicating lamps located near the levers shown in Fig. 2. These lamps remain lighted until the operator upon the scale floor

extinguishes same by resetting the relays. At this signal the flow of grain is stopped by the man at the levers.

A picture of the outlet of some of the large storage bins is shown in Fig. 5. A system of white, green and red lights shown in this picture connect with the same kind of a signal in the basement of the river house and in the cupola discharge chutes. These signals are operated by means of the switches shown on the walls, thus an attendant in handling this grain valve, allowing the grain to come out on the belt, is in constant touch with a man at the point where the grain is being delivered either into the elevators, into the car chutes, or into the chutes for a boat. Near each shipping leg in the work house and river house is a 14 position switch as marked *S* in Fig. 6, which provides a signaling by means of bells and red lights in any of the 14 belt tunnels under the storage bins to signal a stoppage of grain in case of a choke up or other emergency.

Similar systems of signaling are installed for the operation of the men handling the grain off of the boats and delivering it to the scale house and for the various routes which the grain may take through the eleva

All of the bells and the horns are of the polarized t without arcing contacts and operate on 110-volt circuits. Extra heavy drum type switches shown in pictures, marked *R*, Fig. 2, were used for the control some of these signal circuits in order to insure relial operation at all times. All of the lamps used for illumi tion and also for the signaling system are enclosed in proof globes.

Cir. No.	Service	Motor					Compensator			Circuit		
		Number	H.P.	Amps.	R.P.M.	Location	Number	Size	Location	Length	Wire	Fu
1	Oat Clipper No. 20	1004236	60	72	514	First Floor Col. A-5	1541121	3	1st Fl. W. Side Col. A-5	62'	No. 1	[illegible]
2	" " " 19	1004238	60	72	514	" " " A-5	1541117	3	" " E " " A-5	54'	" 1	[illegible]
3	" " " 18	1004235	60	72	514	" " " A-6	1541127	3	" " W " " A-6	42'	" 1	[illegible]
4	" " " 17	1004239	60	72	514	" " " A-6	120	3	" " E " " A-6	42'	" 1	[illegible]
5	Storage Ventilating Fan	1003793	R 15	15.5	900	Storage Fan Room	1541183	1	Storage Fan Room	226'	" 8	[illegible]
6	Oat Clipper No. 16	1004242	60	72	514	First Floor Col. A-8	121	3	1st Fl. W. Side Col. A-8	43'	" 1	[illegible]
7	" " " 15	1004251	60	72	514	" " " A-8	122	3	" " E " " A-8	38'	" 1	[illegible]
8	" " " 13	1004249	60	72	514	" " " A-9	123	3	" " E " " A-9	58'	" 1	[illegible]
9	Air Compressor	1003791	15	15.5	900	Air Comp. Room	124	1	Air Comp. Room	83'	" 10	[illegible]

Fig. 7—Layout of One of the Distribution Cabinets on the First Floor of the Work House

Fig. 8—Yard Scene Showing Methods of Yard Lighting With Enclosed Switches on Pole

One Hundred Ninety Motors Are Used

All of the grain elevators, belt conveyors, dryer f ventilators and unloaders which handle this vast amo of grain are operated by 550-volt, 3-phase a.c. mot there being 190 motors in all, varying from 0.5 hp. 140 hp., totaling 8,067 hp. in all. The unloaded mot for unloading grain from the box cars are illustrated Fig. 1. One of the motors for operating the fans m be seen in Fig. 2, also in Fig. 3. One of the 60 hp. mot for operating the oats clippers is shown in Fig. 4. All

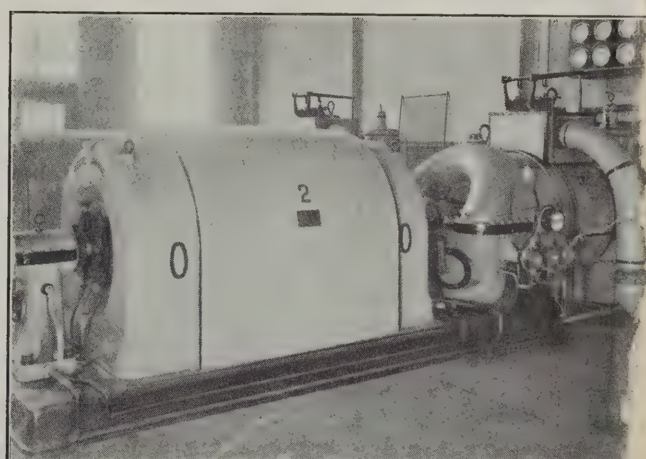


Fig. 9—One of the 2,308 Kva. 550-Volt, 3-Phase Turbo Genera

the motors are of the General Electric Company's squi cage type, 550-volt, 3-phase, 60 cycles. All motors ab 5 hp. capacity are equipped with type C. R.-1034 Gen Electric compensators, with overload relays and a voltage release. Reversible motors are equipped wit compensators, mechanically interlocked.

At each power distribution center each motor circ is protected by fuses located in a dust tight cabinet. The cabinets, as well as all of the lighting and signal cabine are located in dust-proof room with self-closing door. The 3 phases in each power cabinet are separated by slat barriers, reducing to a minimum the danger of a man getting across phases when removing or replacing switches. There are 34 dust-proof rooms for the power

lighting cabinet. All wiring between the distribution ıets and the compensators and between the compensa- and motors is entirely closed in metal conduits. The ngement of the circuits in the cabinet is indicated by liagram, examples of which are shown in the illustra- n, Fig. 7.

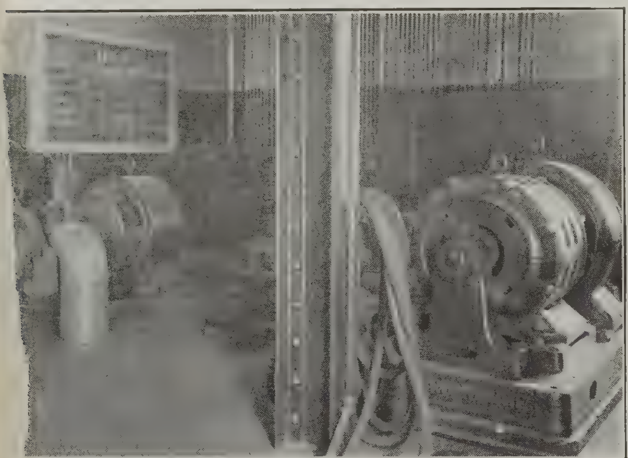
Lighting Units Are Vapor Proof

All lighting throughout the elevator buildings is car- l out with vapor proof fittings, Crouse-Hinds V series lulets with globes and guards being used for this pur- e. All push button switches are installed in Crouse- ds FD or FS series condulets, fitted with type DS m tight covers. Lighting panels are all of the dead it type with tumble switches mounted in dust tight ıets in dust proof rooms. With the exception of the shed all lighting consists of 60-watt mazda lamps. rack shed contains 100-watt lighting units. Outside lighting, illustrated in Fig. 8, is with 500-watt units Benjamin reflector sockets. All receptacles and plugs use of extension lights are of a heavy design manu- ured by the Oliver Electric & Mfg. Co. All extension its are heavy vapor proof hand portables by Benjamin g. Co.

A 50-station automatic telephone board furnishes means communication between all parts of the plant. In the vator proper all telephones are of the mine type, marked in Fig. 2, with separate loud ringing bells operated ectly on the telephone ringer circuit. Speaking tubes bell signals, furnish additional means of communica- 1.

Power Switch Boards Were Rebuilt

The generating equipment consists of two 2,308-kva., -volt, 3-phase, 60-cycle, Westinghouse turbo-genera-



. 10—Equipment Under Balcony in East End of Power House. Small 50-Kw. Turbo Generator on the Left is Used for Field ation. In the Center Behind the Beam is the 12.5 Kw. Set.

and one 770-kva. turbo-generator of the same voltage Fig. 9). Each turbine has a jet type condenser, the r water being used for condensing. At the time of the losion the roof of the power house was forced down the weight of the falling concrete. The gages and ernor of one of the larger machines were smashed.

A 50-kw. Westinghouse direct current turbo-generator, wn to the left of Fig. 10, is used for emergency excita- n of the generators and is used for lighting at night. 50-kw. motor-generator to the right of the picture, is used for field excitation normally. A 12.5 kw. motor-generator set in the center of the view behind the beam, is used for charging the battery and for signal operation. The storage battery consists of 51 cells of E. S. B. Co., Type E-11, and is used to operate all of the generator, feeder and remote control switches; the indication lamps, the elevator signals and emergency lighting, and can be used for emergency excitation of the generators.

The switch-boards are located on a balcony to the east end of the power house. The main switchboard is of the

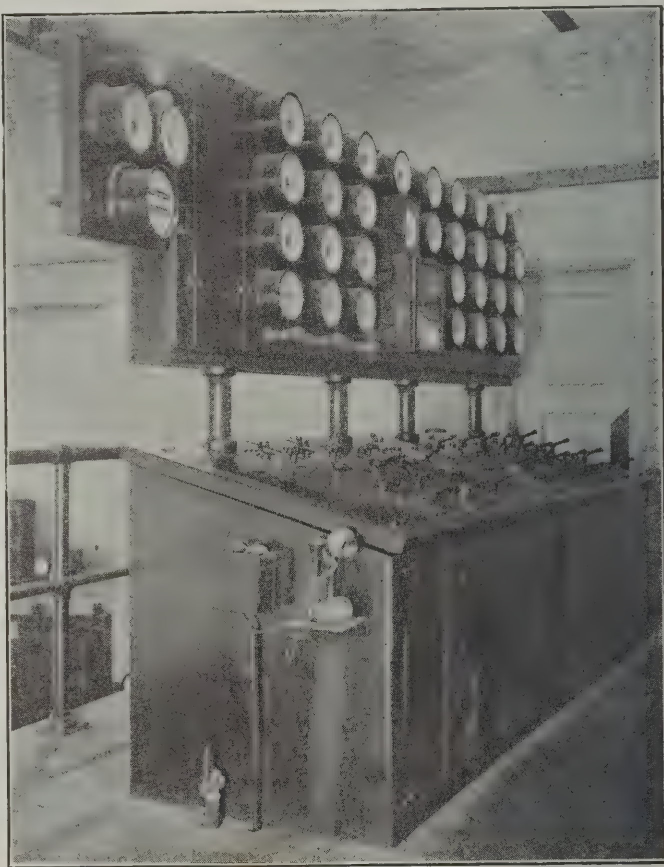


Fig. 11—The Bench Type Switch Board Has All the Switches Controlling the Generator and Feeder Circuits

bench board type as shown in Fig. 11. This board controls the generators and feeder circuits. Each generator panel is equipped with an a.c. ammeter, a d.c. ammeter, a power factor meter, a volt switch, a synchronizing lamp and switch, a generator field switch, a governor control switch, a generator field rheostat and switch, and a main generator oil switch control and indicating lamps. Mounted on the swing bracket to the side of the generator panels is a frequency meter, a synchronoscope and two volt-meters, one of which is connected to the bus bars and the other to the incoming generators.

There are five feeder panels, each one being equipped to control four feeder circuits, each circuit having an a.c. ammeter, and a control switch with indicating lamp. Two overload relays for each circuit are mounted on the back of the board. Between the generator and feeder panels is a panel with the totalizing ammeter, kilowatt hour meter and the graphic watt hour meter, ground indicating lamp, a.c. ammeter switch and feeder alarm switch. A large portion of the bench type switch board was torn off and half of the meters demolished. The field rheostats and

switching gear were torn down. The photograph shows this equipment as replaced.

Exciter and Lighting Panels Were Destroyed

Mounted on the same gallery and facing the bench switch board is the exciter and lighting switch board and generator field rheostat (see Fig. 12). There are two panels each equipped with 10 of the 3 pole, double throw switches for lighting feeders, a kw. hr. meter, an a.c. ammeter and a controller switch for the transformer oil switch. The 3 pole double throw switches are used for throwing the lighting from the 3 wire a.c. to the 2 wire d.c., so that the exciter set can be used as a night lighting generator.

The panel No. 3 is for the motor generator battery charging set and is equipped with a d.c. ammeter, a voltmeter, a reverse current circuit breaker, a battery charging switch, an oil switch and a control switch for the automatic starter on the first floor. Panel No. 4, contains the signal and switch operating equipment, consisting of d.c. ammeter, 6 circuit switches, a circuit breaker for feeder switch operation, a d.p.d.t. switch so that current

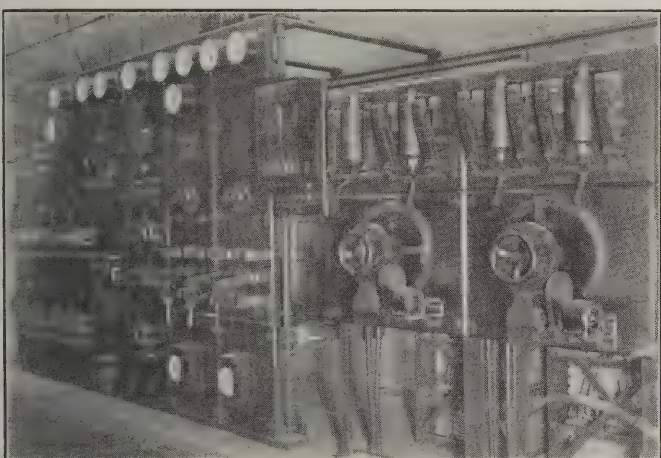


Fig. 12—Exciter and Lighting Switchboard. Two of the Main Generator Field Rheostats are Shown on the Right

may be taken from the battery or the exciter bus bars for the operation of the switches and lamps.

The panel No. 5 is for the control of the motor generator set and is equipped with a d.c. ammeter, d.c. voltmeter, a.c. ammeter, and control switch for the oil switch and the automatic starter, two s.p.d.t. knife switches for transferring the exciter from generator busses to common busses, and also a field rheostat for the generator end of the set. The panel No. 6, Fig. 12, is for the turbo-generator set and has the same equipment as panel No. 5, excepting the motor equipment and a.c. ammeter. On the side of this panel is a Westinghouse a.c. voltage regulator. In a line with these panels are the a.c. generator field rheostats and field switches, shown to right in Fig. 12. The field switches are operated from the bench board, two switches for each rheostat, so that generator fields can be excited from generator busses or from common busses.

The field rheostats are motor operated and controlled from the bench board. The main a.c. bus bars, feeder and generator oil switches are located in the basement and are set up in the individual concrete cell construction. Each feeder and generator is equipped with oil switch current transformers and disconnecting switches. For the lighting circuit, three 50 kva. transformers shown to the background of Fig. 10 are connected in delta on the high side. Secondaries are connected individually to separate secondary bus bars.

The reconstruction of the entire electrical equipment was handled through the electrical engineering department of the Chicago & North Western. It is of interest to note that approximately 9,000 conduit fittings and boxes were used and 65,000 ft. of conduit of from ½ in. to 3 in. was required. Over 15,000 of the enclosed type dust proof lighting units were used. Insulated wire of sizes from No. 14 to 500,000 c.m. to a total of 75,000 ft. was used and 6,000 ft. of galvanized wire was required.

Improvements at Morris Park Shops

Extensive improvements have been completed and others are still under way at the Morris Park Shops of the Long Island Railroad Company. They include the erection of a new office building and new storehouse, installation of new machinery and two new overhead cranes for the locomotive shop, the remodeling of the old office building into a wheel shop with a new complement of machinery.

The new office building, 40 feet by 80 feet, is of concrete construction, and will be completed shortly. It has three floors and basement. The basement has been planned to accommodate a modern restaurant for supervisory and office forces, and also contains rooms for storing records.

The first floor will be utilized by the superintendent of motive power's general office force, and space has been set aside for an information and employment bureau.

The second and third floors will be occupied by the superintendent of motive power and engineering forces.

The new storehouse, also in the course of erection and nearing completion, with dimensions 40 feet by 100 feet, is also being built of reinforced concrete. It has three floors and basement, is equipped with electric elevators for freight, and an electric dumbwaiter will speed up delivery for light material to the delivery counter located on the first floor. The entire building is being equipped with the most modern type of adjustable steel shelving. On the third floor the office of the storekeeper and his force will be located.

The old office building and present storehouse will be remodeled into a wheel shop, and a complete monorail system for unloading wheels and axles and handling this material in shop, will be installed. Other installations will include new axle lathes, boring mills, wheel press and grinding machines.

The locomotive shop is to have a number of new machines, including a side-head boring mill, slotter, bushing press, cylinder, radial drill and a 20-foot by 10-foot bed engine lathe.

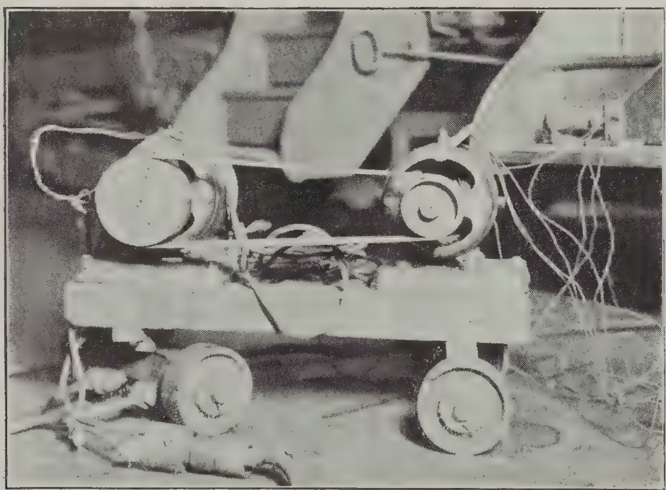
To speed up the handling of locomotives for repairs, the present method of unwheeling locomotives by dropping wheel with drop pit, will be abandoned; likewise, the two small 25-ton cranes will be replaced with a new 150-ton crane, running on a new steel runway the entire length of the locomotive shop. The light work will be handled by a new 10-ton crane.

The entire motive power plant at Morris Park will be equipped with the new automatic telephones.

Panel Testing Combination

A very convenient combination of two shunt motors, mounted on a small truck, for the purpose of testing car-lighting panels when the car is standing in the yard, is being successfully used at the Hoboken Terminal of the D., L. & W.

The two motors were secured from two dish washing machines, formerly used on a dining car but which were discontinued. Both of the motors are exactly alike, being one-quarter hp. each and designed for operation on 30-volt circuits. In the combination which the carlighting men have made up, one of the machines is used as a generator while the other still operates as a motor. A small leather belt connects the two and a pulley ratio of 2 to 1 is used which causes the generator to run twice as fast as the motor. As ordinarily used, the motor is connected to a 60-volt charging line in the yard with a resistance in series in the armature circuit. By this means it is possible to control the speed of the motor and hence the speed of the generator from zero to 2,000 r.p.m.



This Portable Combination Motor-Generator Set Has Proved Most Convenient

This combination is especially useful in testing panels when giving the equipment a general overhauling. The current required for panel operation is usually about five amperes, and it is possible to make all tests on the panel except the determination of current setting. The usual method is as follows: Disconnect the generator at the panel or on the block under the car and connect the combination generator in the place of the regular machine. Bring the motor slowly up to speed and note the voltage setting at which the switch cuts in. Continue speeding up the generator and the panel will operate the same as on the road and show the maximum voltage setting.

With the U. S. L. outfit, run up sufficient voltage to operate the relay on the type C panel. Having reached that voltage and determining what the setting of the relay is, the floating voltage of the panel may then be determined by closing the ampere hour meter contacts. If the setting varies from standard it is an easy matter to adjust. Tests made on the road show that settings never vary more than one-quarter volt from the results obtained by the motor generator set.

If the panel is not compensated for heating, it is necessary to run sufficient length of time to bring the temperature of the coil up to the average operating temperature, which on the Lackawanna is 80 deg. F. or take the temperature readings on the coils as they are tested and correct them to 80 deg. F., making allowances of one volt for every 10 deg. of temperature. For example, start the machine on a cold panel with a maximum voltage of 35 volts. At 50 deg. F., the correction would be three volts or 38 volts approximately at 80 deg. F.

The advantage of such a testing outfit is that it is easily portable, and when it is used it is not necessary to have two cars together in order to furnish 60 volts for testing as is sometimes done. As it is, when operating on the charging line, considerable amount of energy is absorbed in the rheostat. The combination outfit can also be used in making tests on the lamp regulator since the generator can carry three or four lamps long enough to allow setting or checking of the regulator.

The Little Old Red Caboose

I'm just an old tail-ender
That's tied to the end of a freight,
And I swing when I'm on my way
With the train that's seldom late.

I have to give way to the Pullman
That carries the traveling throng,
And I follow the loaded box car
That rumbles and grumbles along.

But there isn't a car in the outfit
That ever was put in use
That means so much to a railroad man
As the little old red caboose.

—*Port Jervis Union.*

The Radiot

By Mrs. Louis D. Moore

Yes, Daddy has a radio—
He's making one for Son,
And every night when he comes home
I'm 'fraid he'll bring me one.

He used to say at eight o'clock,
"I'm tired and sleepy too.
I think I'll go to bed right now.
I'm sleepy. Aren't you?"

But now he sits up late at night,
Receivers at his ears,
And calls out in great ecstasy
When some new place he hears.

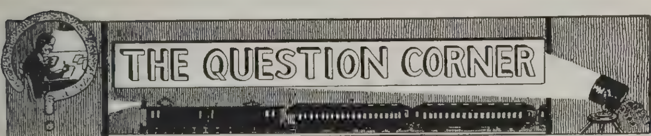
We have to go on our tiptoes
And speak in accents low,
Or Daddy'll point his finger, "Sh!"
When at his radio.

But Daddy always has some fad,
So there's still hope for him.
He's had the auto bug and golf,
He's fished, he's learned to swim.

So we won't say too much to him
About the radio,
For one good thing we must admit,
It keeps him home, you know.

The money that you take care of today will take care of you tomorrow. Observe this truism and you will be financially independent.

If self-preservation is the first law of nature, saving and safe investment should be the first impulse of personal finance.



Answers to Questions

1. I have been using a radio outfit with a WD-11 tube and a dry battery, but these batteries do not seem to last very long and I would like to get some kind of battery that would not have to be replaced every week. Would a bluestone gravity battery be satisfactory?

* * *

1. There are several cells which could be used in the place of the usual dry cell. The principal objection to the gravity battery is its large size and danger of slopping and if used as a *B* battery, might cause battery noises. In any case this type of cell should be used on closed circuit work and would be satisfactory if used for an *A* battery.

The Daniel cell will give good service on closed circuits and can be made from small jam jars. This type of cell gives about 1.07 volt. Fig. 1 shows the construction of the cell which is comprised of a solution of one part sulphuric acid to 15 parts pure water, a porous cup, containing a saturated solution of bluestone, together with copper and zinc rods inserted as shown in the illustration.

The Grenet cell will give very good results for a short time and has an e.m.f. of two volts. It also has a larger current capacity. This cell may likewise be made from jam jars as shown in Fig. 2, using carbon from old dry cells and pencil zincs. The electrolyte is prepared as follows:

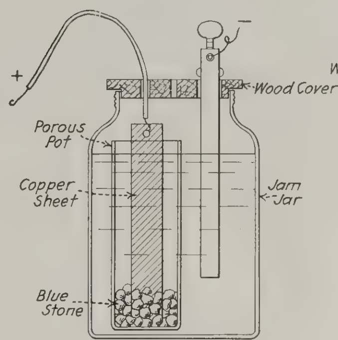


FIG. 1

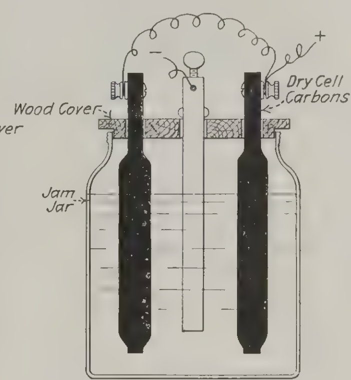


FIG. 2

Two ounces of bichromate of potassium to a quart of water—add very slowly one ounce of sulphuric acid—stir well.

The carbon cell is, I think, the best of all for open circuit work such as *B* battery. Fig. 3 shows a simple cell of this type also made from a jam jar. The solution is four ounces of sal ammoniac to a quart of water and the more carbon you use, the more current you will get.

The Volta pile is a very compact means of obtaining a

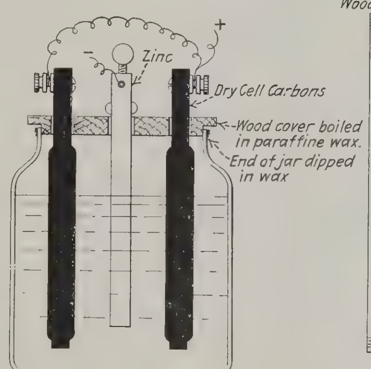


FIG. 3

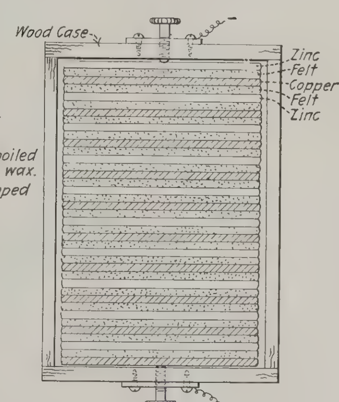


FIG. 4

high voltage for short intervals and is one of the oldest ways known of obtaining current electricity.

This was the power center of the wonderful submarine "Nautilus" of Jules Verne's imagination. Fig. 4 shows one way to make this pile which will be very satisfactory for a *B* battery.—A. H. M.

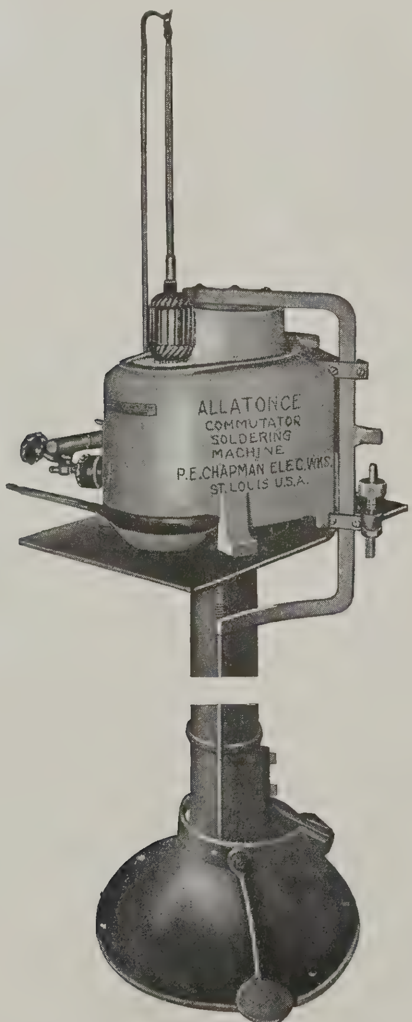
Questions for February

1. I would be pleased to have some suggestions for charging an ordinary automobile accumulator which I have. The available supply is 110 volts alternating current, which sometimes varies and reaches a higher value. —J. L.

NEW DEVICES

Commutator Soldering Machine

A device for soldering the armature leads to the commutator segments of small armatures has been developed by the P. E. Chapman Electrical Works, St. Louis, Mo. It is called the Allatonce Commutator Soldering Machine

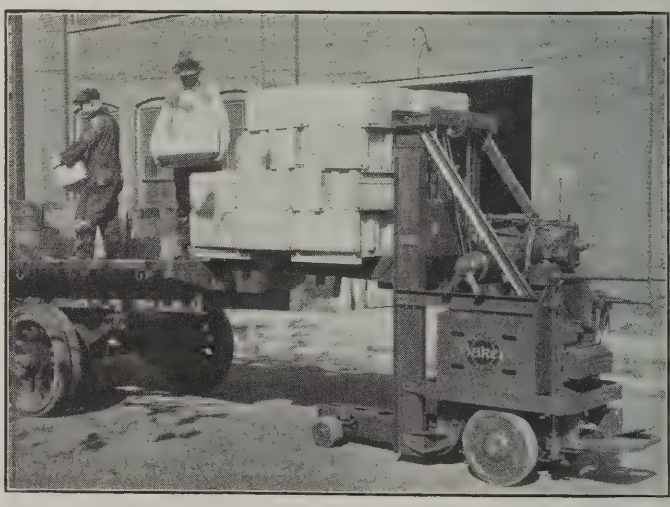


Allatonce Soldering Machine

and provides for soldering all of the leads in the commutator head by emersion at one time. The armature which is to be soldered is supported on a hanger with the commutator end down and the shaft and ring insulation are protected from the solder. During the soldering operation the armature remains stationary and the solder is raised to the height of the joint by depression of the treadle. Raising the level of the solder in this manner automatically cleans it of dross. Burners are provided for melting and keeping the solder at the proper temperature, which can be adjusted for either natural or artificial gas. An outside jacket protects the operator from the heat of the gas flame and if desired the products of combustion may be piped to the outside. A solder level stop is provided for the purpose of increasing the speed of operation and preventing flooding back of the commutator. Two sizes of machines are being marketed; one provides for commutators up to two inches in diameter and the other is for commutators two to four inches in diameter.

Elevating-Platform Truck With Six-Foot Lift

An elevating platform truck, known as the Hy-Lift, capable of hoisting a 4,000-lb. load 6 ft. from the floor, has been placed on the market recently by the Baker R. &



Baker Hy-Lift Truck Efficiently Transports and Elevates Material

L. Company, Cleveland, Ohio. This truck is intended for hoisting purposes, but is often used on short hauls. It will practically double and sometimes triple the capacity of store houses for heavy material. It can be used for loading wagons or freight cars and, in machine shops

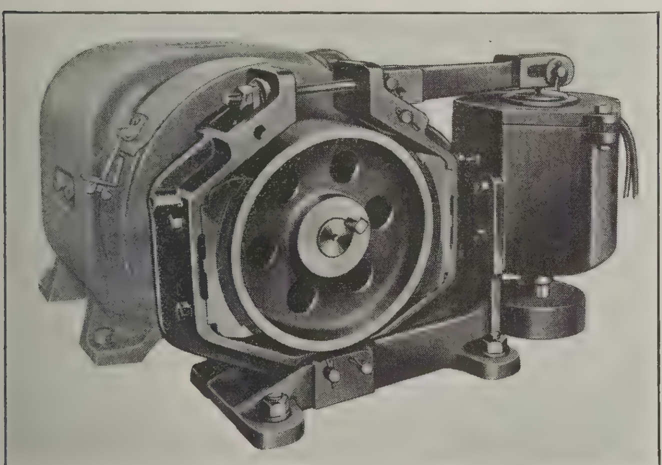
without crane facilities, is valuable for lifting heavy dies or parts to and from the machines.

The new Baker truck is of rugged construction throughout, being interstandardized with previous models as regards motor, transmission, universal joints, wheels, tires, controller, etc. It is also equipped with the Baker duplex compensating suspension. A two-cable hoist, either of the cables being strong enough to carry more than the rated full load, is used, and the advantages of the cable system of hoisting is especially important in this case where a long steel screw would be subject to dirt, abrasion and severe bending strains. This standard truck lifts 72 in. but trucks can also be furnished with 48-in. or 60-in. lift if desired.

The truck is arranged with a two-wheel drive and a four-wheel steering mechanism, providing for turning in a minimum outside circle of 107 in. With a load of 4,000 lb., the maximum speed of the truck is 4½ miles per hour, and without load, 6 miles per hour. The brakes are operated by a foot pedal and interlocked with an automatic switch and controller. The lifting speed without load is 11 ft. per min.; with 2,000 lb. load, 7 ft. per min.; with 4,000 lb. load, 5 ft. per min. The plate steel platform is hinged at the point of attachment to the roller head so that the tapered outer end of the platform tips if it catches when lowering the load. All parts of this truck are readily accessible for lubrication, adjustment or repair.

Quick-Acting Solenoid Brake

A solenoid brake with important structural advantages for crane service has been developed recently by the Whiting Corporation, Harvey, Ill. This brake (Type C) is designed to be quick-acting, powerful, provided with interchangeable parts and easy to adjust. The brake arms are so pivoted that the shoes release equally at all points and there is no chance of the shoes dragging at the lower end. This is also a big advantage in applying the brake, as the shoes bear equally at all points, resulting in quick braking action and uniform wear. All parts for the same size brakes are interchangeable. Brake wheels and shoes are interchangeable with like parts on the Whiting Corporation's standard foot brake.



Whiting Type C Solenoid Brake for Crane Service

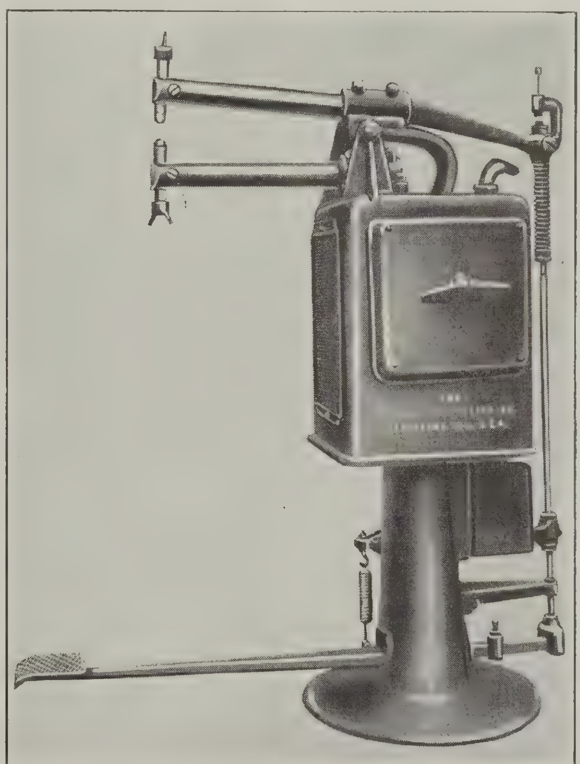
In the Type C brake all parts subject to stress are steel castings. For direct current the plunger is of soft iron of large diameter, which gives a fast operating solenoid, even at light loads. The solenoid spool is of brass tubing with a vulcanized fiber sleeve over the tubing and fiber ends. The coils, wound with asbestos-covered wire of ample size, are designed to operate the brake at about 40 per cent full load current and remain open at 10 per cent or less of the full load current. The voltage loss in the coil in most sizes averages less than 4 and in no case more than 7 per cent.

Before putting the Type C brake on the market, it was put through a series of exhaustive tests. A 12-in. brake was mounted on a 25-hp., 550 r.p.m., direct current motor. In the complete test, the motor was stopped 50,000 times at a rate of 325 stops per hour, after which the brake is said to have showed no signs of wear except the usual shoe wear.

During this test a number of different lining materials were tested and the one selected showed the following characteristics: Material not affected when operating with the brake wheel at dull-red heat; average wear .0005 in. per 1,000 stops with motor running 1,800 r.p.m.

Spot Welding Machine

The U. S. Electric Welder Company, 327 Permanent Building, Cleveland, Ohio, has placed on the market a new type of welder, S A F, for light and medium stock. The internal automatic reactance prevents breakdown at overload and enables the welder to handle heavy stock without overheating. The automatic switch is equipped with magnetic blowout, removable contacts and is enclosed. A 5-point pivot switch provides different voltages at the welding point, which are water-cooled by means of a new system. All mechanical movable parts are of a special alloy or cast steel, therefore, light.



U. S. Spot Welder

About four seconds per weld is required for 3/16 in. stock and about 4,000 welds per hour can be made on 1/16 in. bright sheets.

General News Section

The Chicago & Eastern Illinois is contemplating the construction of a new roundhouse and shop buildings at Evansville, Ind., to cost approximately $3,000,000.

The Atchison, Topeka & Santa Fe contemplates the construction of two new roundhouses, a car repair house and extensive yard improvements at Emporia, Kan., to cost approximately $5,000,000.

The Seventh Annual Meeting of the American Gear Manufacturers' Association will be held at Hotel Cleveland, Cleveland, Ohio, April 19, 20 and 21. The detailed program for this meeting will be announced as soon as it is completed.

A contract has been awarded to the Roberts & Schaefer Company, Chicago, by the New York Central for the construction of a 100-ton 2-track, reinforced concrete automatic electrically operated coaling station to be located at North Judson, Ind.

The United States Civil Service Commission announces an open competitive examination for the Federal Civil Service for the position of radio engineer at from $4,000 to $5,000 a year, associate radio engineer at from $3,000 to $4,000 a year and assistant radio engineer at from $2,000 to $3,000 a year. Further details may be had by applying to the headquarters of the commission at Washington, D. C.

The American Engineering Company, Philadelphia, Pa., manufacturers of Taylor stokers and marine auxiliaries, has taken over the Standard Crane & Hoist Company and the patent and manufacturing rights to the mono-rail electric hoist formerly known as the Standard. H. S. Valentine, chief engineer of the Standard Crane & Hoist Company, is directing the sales and supervising the manufacture of the hoist for the American Engineering Company.

At a recent meeting of the executive committee of American Gear Manufacturers' Association, A. W. Copeland, president of the Detroit Gear and Machine Company, was elected to fill the vacancy on the committee caused by the death of John B. Foote, president of the Foote Brothers' Gear and Machine Company, Chicago, Ill. Mr. Copeland's membership on the committee will continue until the annual meeting of the association in April when this position will be filled by election.

The next annual meeting of the Electric Power Club will be held on June 11 to 14 inclusive at the Homestead, Hot Springs, Va., where the association was organized in 1908. It is expected that a considerable amount of important standardization of electric power apparatus will be effected at that meeting because the new edition of the Electric Power Club's handbook will be published soon thereafter; and all of the different sections of the club are working to accomplish as much as possible this spring in order to get their work into the new handbook.

A new $700,000 building is being constructed for the Westinghouse Electric & Manufacturing Company in Chicago. The building, which is located at West Pershing Road and Leavitt street, will be used for a combination district sales office, warehouse, and service shop and is the first of three buildings to be erected at this location. It will be seven stories high, will contain 218,000 sq. ft. of floor space, and will be of reinforced concrete construction. Work was started November 1 and will be completed about the first of next May.

The United States Patent Office recently issued a decision signed by three examiners in chief which affirms the priority of a welding machine invention to Claude J. Holslag of the Electric Arc Cutting & Welding Company, Newark, N. J., on all counts. The patents refer to apparatus for and a method of using alternating current for arc welding by means of a transformer. The patents were issued June 3, 1919. The first decision in Mr. Holslag's favor was given in May, 1922, and the affirmation of that decision was rendered January 12, 1923.

The Philadelphia & Reading has installed automatic telephones in its locomotive shops and storehouse at Reading, Pa. The system consists of 60 telephones in the locomotive shop and 17 in the storehouse. The central equipment is located in the main office building at the locomotive shop. It was found advisable to install the automatic system instead of increasing the size of the switchboard and employing an additional operator. It was also found that the new system is able to handle 20 per cent more calls in a given time than were formerly handled by the manual system. The average length of time to complete a call on the automatic system is 13.3 seconds as compared with 50.6 seconds on the manual.

The St. Louis-San Francisco has installed two electrically operated water coolers in its coach 1080, operating in the Kansas City-Florida Special. The Frisco is the first railroad to install devices of this nature for the purpose of cooling drinking water in passenger coaches. The small refrigerating plants which cool the water are operated from the electric lighting system and automatically maintain the temperature of the water between 40 and 45 degrees.

This device entirely eliminates the use of ice in the coolers and is sanitary and economical. The coolers are manufactured by the Safety Car Heating and Lighting Company and were installed under the supervision of the railroad electrical engineering department.

The Western Electric Company, New York, made important organization changes effective January 15, as follows: F. A. Ketcham, general sales manager, has been appointed general manager of the supply department, and G. E. Cullinan succeeds him as general sales manager. Mr. Cullinan entered the employ of the Western Electric Company upon his graduation from Williams College in

1901 and for several years was connected with the New York office. He went to St. Louis in 1907 where he served as manager from 1909 to 1918 and then went to Chicago as central district manager. L. M. Dunn, for the past three years manager of the eastern district, which includes the New York and the New England territory, has been appointed general merchandise manager on the general manager's staff. W. J. Drury succeeds Mr. Dunn as manager of the eastern district. Mr. Drury has been sales manager at New York for the past three years, and is succeeded in that capacity by J. F. Davis who has been sales manager of the Boston branch for the same period. T. E. Burger has been made sales manager at Boston. Mr. Burger was for 13 years connected with the Los Angeles and San Francisco organizations having served as sales manager of the former. More recently he has been on the staff of the Society for Electrical Development, returning to the service of Western Electric organization in 1922. W. P. Hoagland, sales manager at Chicago, has been appointed central district manager in charge of the Chicago and Minneapolis branches. J. H. Gleason, power apparatus sales manager at Chicago, has been appointed Chicago sales manager. H. L. Grant, for the past three years general appliance sales manager at New York, has been appointed Erie district manager, a new grouping of the distributing houses at Cleveland, Pittsburgh, Detroit and Cincinnati. Mr. Grant's headquarters will be at Cleveland. A. M. Collins continues as manager at Cleveland.

Plenty of Power in New Zealand

Proposed hydro-electric developments in New Zealand involve a total expenditure of $60,000,000. This is to be spread over a period of ten years. The financial condition of New Zealand has rendered it necessary to postpone for a couple of years the commencement of the main works at Lake Waikaremoana and to hold over a number of the smaller developments in the South Island until power boards have been constituted to handle the question of distribution. Transmission lines and projects to be developed will be pushed ahead in order to make the supply of electricity general as possible up to the capacity of the head-works at each site.

The mains from Lake Coleridge will be extended into Otago and North Canterbury and those from Mangahao will reach to Wanganui and Napier. These are in addition to lines already under construction.

Electric Coal Handling Machinery

The Philadelphia & Reading has awarded a contract to the McMyler-Interstate Company, Bedford, Ohio, for furnishing and erecting at their Port Richmond terminal, Philadelphia, a 120-ton car dumping machine to replace the gravity trestle pier No. 18, which was destroyed by fire on November 24. This coal dumping machine will cost $1,500,000 and will be capable of handling all sizes of cars. The new plant is to consist of a pier 900 ft. long, with car dumping machine, power plant, thawing plant, car haulage machinery, mechanical trimming and boat haulage machine, and machines designed to deliver coal direct from railroad cars to vessels. Provision will be made for delivering coal to vessels of the type usually engaged in the coal trade, not exceeding a beam of 60 ft. or a height of 36 ft. from the water line to the top of the hatch. This machine will be capable of handling 40 cars per hour at the high elevation for delivering to maximum size vessels, and 43 cars for loading the smaller type vessels of the coal trade. On the lower end of the telescopic chute will be placed a mechanical trimmer. A "barney" or car haulage machine will be provided for hauling cars from the foot of the incline on to the cradle of the dumper. The thawing house is to be 440 ft. long, having four stalls, each capable of handling 11 cars, or a total of 44 cars at one time. The entire plant is to be complete and ready for service by the fall season this year.

Proposed Electrification in Mexico

Alfred Crewdson, of Manchester, England, and British associates who own the Coahuila & Zacatecas Railroad, are making preparations to electrify that line which runs between Saltillo and the mining town of Concepcion del Oro, 78 miles, with a branch line from San Pedro to Avalos, 17 miles. The railroad was built some years ago, primarily to serve the Mazapil Copper Company, Ltd., which is owned by the same interests. The company owns copper mines at Concepcion del Oro and Mazapil, and operates a smelter at the former place and another one at Saltillo. The railroad is of 3-foot gage. Stephan Phindler, electrical engineer for the Mazapil Copper Company, Ltd., is now making the surveys and estimates for the proposed electrical installation. The project involves the building of a dam and water storage reservoir and the erection of a hydroelectric plant. The advisability of changing the gage of the line to standard and extending it through the state of Zacatecas is being considered. The road now connects with the National Railways of Mexico at Saltillo, but there is no interchange of cars because of the difference in gages of the two lines. It is stated that by extending the road about one hundred miles a rich mineral country as well as valley lands that are highly susceptible of agricultural development would be given a transportation outlet. R. H. Jeffrey is vice-president and general manager of the Coahuila & Zacatecas Railroad, with headquarters at Saltillo.

Personals

W. W. Reddie has been appointed assistant to manager of the industrial department of the Westinghouse Electric & Manufacturing Company, according to a recent announcement. He will be in charge of the railroad shop, metal working, machinery manufacturers, and material handling machinery sections of the department. Mr. Reddie has long been active in promoting the use of new motor and control applications in railroad and metal working shops and in the development of electric arc welding equipment and is well equipped to fill his new position.

S. E. Marks has been appointed director of traffic and shipping for the Westinghouse Electric & Manufacturing Company. Mr. Marks will have general oversight of the traffic, shipping and packing activities in all of the electric plants at East Pittsburgh, Pa.; East Springfield, Mass.; Newark, N. J.; Mansfield, Ohio; Cleveland, Ohio; Trafford, Pa.; Derry, Pa.; South Bend, Ind., and Homewood and Pittsburgh, Pa. W. H. Reinherr has been appointed assistant superintendent in charge of shipping activities at the East Pittsburgh Works, and Paul K. Shultz, supervisor of traffic.

T. S. Burns, recently connected with the Electric Traction Department of the New York Central, is now reporting engineer of the Power Corporation of New York, at Watertown, N. Y.

L. L. King has been appointed electrical engineer of the Atchison, Topeka & Santa Fe Ry., with headquarters at Topeka, Kans. Mr. King was formerly assistant electrical engineer and succeeds C. E. Nutter, deceased.

Wm. F. Whiteside has been appointed specialist in steam railroad electrification for The Ohio Brass Company, Mansfield, Ohio. Mr. Whiteside was previously with the Westinghouse Electric and Manufacturing Company.

H. E. Seifried, secretary-treasurer of the Stone Franklin Company, St. Louis, Mo., has been appointed assistant to the vice-president of the Franklin Railway Supply Company, Inc., Chicago, succeeding H. M. Clawson, resigned.

Major J. L. Hays has joined the sales organization of the Safety Car Heating & Lighting Company, New Haven, Conn., as commercial engineer, and will be located at the Philadelphia, Pa., office. Major Hays graduated from Lehigh University in 1909 with a degree of electrical engineer and then joined the electrical department staff of the Baltimore & Ohio, working successively as mechanic, draftsman, inspector, general foreman and assistant engineer. He later served with the Seaboard Air Line as electrical engineer until he was commissioned as a major in the Quartermaster's Corps at the beginning of the war, in charge of the electrical section of the engineering branch, being responsible for electrical construction for the army in the United States. At the conclusion of the war he joined the Stone-Franklin Company as electrical engineer, serving until the Safety Car Heating & Lighting Company absorbed the car lighting interests of the Stone-Franklin Company on January 1 of this year.

Major J. L. Hays

A. H. Darker, chief electrical engineer of Messrs. J. Stone & Co., Ltd., of Deptford, London, England, has started on a trip around the world and will visit points in America before returning to England. Mr. Darker has previously visited the United States and Canada on many occasions in connection with the electric lighting of railway trains. Charter members of the Association of Railway Electrical Engineers will remember an address given by him in Chicago in 1908.

S. I. Hopkins, formerly representative of the Safety Car Heating & Lighting Company, with headquarters at 1015 Central National Bank Building, St. Louis, Missouri, has been promoted to manager of the St. Louis office. Mr. Hopkins began his business career as stenographer and clerk in the office of the assistant general freight agent of the Baltimore & Ohio Southwestern Railroad at St. Louis, September 1, 1898, and left that position a year later to become stenographer and clerk in the office of the division superintendent of the Missouri Pacific Railroad at Little Rock, Arkansas. In July, 1901, he left the Missouri Pacific to take the position of secretary to the purchasing agent of the Missouri, Kansas & Texas Railway, where he remained until August, 1904, when he entered the service of the Safety company as an inspector. In 1911 he was appointed sales agent and in 1919 representative, which position he held until his recent promotion.

Obituary

C. E. Nutter, electrical engineer of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., died on January 20.

Trade Publications

The Triumph Electric Company, Cincinnati, Ohio, is issuing a four-page, illustrated, envelope folder describing the application of Triumph electric motors to the operation of refrigerating machinery.

Electric Furnaces.—An electric furnace, which has been in operation for five years, has been used to melt 26,000,000 pounds of metal and is still in good condition, is pictured in a bulletin issued recently by the Detroit Electric Furnace Company, Detroit, Mich.

The Ohio Brass Company, Mansfield, Ohio, has recently issued its catalog No. 210 entitled Imperial Headlights for Electric Railways. The book is 8 in. by 10½ in., bound in flexible imitation leather and contains 252 pages of well illustrated matter pertaining to headlight equipment used in electric railway service.

The Nela Research Laboratory, National Lamp Works of the General Electric Company, Cleveland, Ohio, has recently issued Abstract-Bulletin No. 3, Vol. 1, containing a number of papers covering descriptions of pure and applied scientific research as pertaining to various problems of illumination. The book is a paper-bound volume of 522 pages, containing numerous charts, diagrams and photographs.

Conveyors.—A portable loader catalogue was recently issued by the Link-Belt Company, Nicetown, Philadelphia, Pa., embracing the company's entire line of portable equipment. It is the most up-to-date and complete catalogue ever issued by the company. It is 8½ by 11 in. and contains complete specifications of all of the standard machines which include a large one-man power swiveling loader, a portable belt conveyor, a standard type "A" machine for anthracite coal, and a "CS" loader for handling sand and gravel.

Black & Decker Manufacturing Company, Baltimore, Md., has just issued its 1923 catalogue, describing and illustrating the various portable electric tools and shop equipment which it manufactures. The catalogue is 8½ by 11 in., contains 32 pages, paper binding. The apparatus listed in its pages includes electric grinders, valve grinders, screwdrivers, electric bench and pedestal grinders and electric air compressors.

Railway Electrical Engineer

Volume 14 MARCH, 1923 No. 3

In Time of Plenty

"In time of plenty, prepare for famine," may be taken as a very appropriate slogan for the electrical department on the majority of railroads to-day. The railroads are in a period of prosperity. When the lean years come, it is exceedingly difficult to obtain equipment no matter how badly it is needed. This being the case, he is a wise executive who in the time of plenty does everything in his power to prepare for the time of scarcity. It is folly to expect that each succeeding year will be as good or better than the year before. Experience has shown unmistakably that good and bad seasons follow along alternately in a more or less regular cycle. Look forward to your needs for the future as far as you can and go the limit in preparing your department with those things which it has long needed and which will be of tremendous importance in its economical operation in the future. It is usually difficult to secure all of the things which you need even in times of plenty, but when money is tight and earnings poor it is practically impossible to obtain even those things which are absolutely essential. Take time by the forelock and make the most of the present opportunities to better your department.

Will You Co-operate With Us?

Did it ever occur to you that the things which you are doing in your daily work on the railroad are of great interest to other electrical men who are trying to accomplish the same results, but possibly in another way? Are you among that class of readers who have got into the habit of finding fault with your business paper because it does not contain the quality and quantity of articles which you would like to see in it? Did you ever stop to wonder where the material which you see in the paper, devoted to your interest, came from? Have you ever done anything to help others by telling how you managed to solve some difficult electrical problem that caused no end of trouble before you finally succeeded in finding the correct solution?

If any of these questions apply to you, then do you not think that it is about time that you did something to remedy the matter? The man who can tell the most interesting story about the progress and development of electrical work on the steam railroads today is the man who is actually doing the work himself. Many men feel that they cannot write articles for publication, but for the most part this feeling is more imaginary than real. The truth is that there are very few men doing worth while work who are incapable of telling in an interesting fashion just what they are doing. The chief difficulty is that they think they cannot.

A short article on the subject of writing for technical publications will be found on page 76, which we hope will be the means of giving some of our readers sufficient encouragement to tempt them to venture into the field of technical literature. There are a few simple rules given which show clearly enough that the work is not really difficult. It is our earnest wish that this information will inspire some of our friends to give us a greater degree of co-operation than they have in the past. Remember that this is your paper.

Car Lighting Maintenance Records

Systematic keeping of records of all kinds, providing it is not overdone, is most desirable. Much valuable time, however, may be wasted in keeping records which are of doubtful value. Records of inspections of car lighting equipment, as well as records of greasing and overhauling, could hardly be classified as of doubtful value, for there is nothing more important in this line of work than a positive knowledge that the equipment is receiving the right kind of attention. A useful and unique system of such record keeping is described on page 67 of this issue. The method described is used on the Erie Railroad in checking up the maintenance of its through and local service cars. A master record, in the general foreman's office, is kept up to date from the reports sent in from the electricians along the line so that it is possible to tell at a glance whether or not any car is receiving the attention which it should. The system is simple but effective; it has now been in operation for a number of years and the results obtained have been most satisfactory.

Will There Be a Labor Shortage?

An unprecedented labor shortage is prophesied by many prominent industrial leaders. The most obvious methods for counteracting such a shortage are in the adoption and use of labor saving methods and devices; the great majority of the latter are electrically operated. An automatic substation as a labor saver is particularly apparent since the automatic operation does away with the operators. Automatic operation for pumps and air compressors means the saving of labor for the same reason. The simple expedient of an automatic stop applied to a water pump or a battery charging circuit is often of great

value as it is not necessary for an operator to be present during the greater part of the pumping or charging operation. The application of this motor drive and control devices to machine tools adds greatly to their productive capacity. The use of material handling equipment, such as trucks and tractors, loading and unloading devices, etc. should be greatly increased. Good lighting increases the productiveness of labor.

It is the job of the electrical man to install and maintain the greater part of such equipment and he has a great opportunity before him. Methods and devices should be installed to offset the effects of a labor shortage; indeed whether there will be a shortage or not or how severe it may be, depends largely on whether or not such methods and devices are used.

The Helping Hand

A condition which is confronting not a few of the car lighting departments at present is the number of new men that have come into this field to work with little or no special training. While some of these men have had a limited amount of electrical experience in other lines, many of them have had none at all and on some roads it is becoming quite a problem to get out the work in anything like an efficient manner. For the most part, the new men are quite willing to learn all that they can concerning their work.

One large terminal has adopted a clever practical way of meeting the situation. The scheme consists of holding meetings of about a half-hour duration in some convenient room near the work. The meetings are between 3:40 p. m. and 4:10 p. m., so that it is possible for all the men of the first trick and those of the last trick to attend. The idea is to present at each meeting specific information about some particular phase of car lighting work and to treat the subject in such a way that it will be readily understood by all the men. While this plan has been in operation but a few weeks, it has proved most successful for without any solicitation or personal invitation by the foreman the men have turned out in enthusiastic attendance, so eager are they for some knowledge of the fundamental principles of car lighting. With the aid of a blackboard, the speaker is able to illustrate his points by diagrams and thus make the subject more clear than can be done in any other way. By holding the meetings at 3:40, the first trick men have 10 minutes in which to change their clothes and even though the meeting is held on their own time, it is so brief and so filled with information that they want, that they are glad to be present.

Although the plan has been tried only a brief time, it bids fair to continue with great success. There is one meeting each week.

Letters to the Editor

COVINGTON, KY.

TO THE EDITOR:

Your editorial on page 33 of the February issue, "Opportunities Knock for the Electrical Man," is very worthy of commendation.

I have often wondered where the man was that would come out and tell the electrical engineer on the railways, just how backward he was, why he stays put and why the mechanical department seems to hold sway, when in all common sense the mechanical department should be separate and work in harmony with the electrical department. Why some of our railway systems trust electrical equipment to their mechanical departments is hard to understand.

Going back to the advent of electrical equipment on our railways, we find that electricity was gradually adopted (which is usually the case with everything) and naturally the up-keep of the equipment fell on the shoulders of the mechanical department. But as we advanced in the electrical art, it was imperative that the electrical man take possession and develop the new art to its high standing of to-day on some of our transportation systems. It is necessary to say some because the number is very small.

It is a shame to visit some of our railway shops and offices and note the very inefficient methods used by their electrical departments. It is plain to be seen that the work was not planned by an electrical engineer. In most cases the work was not even planned by the mechanical department, because for no other reason than that the department was not qualified to handle such work.

It is possible to save thousands of dollars in every railway shop in the country by the simple process of giving a little attention to power-factor. In one shop I have in mind the power-factor is around 0.40, which is very bad. Why is the power-factor bad? For no other reason than that the installation was not electrical but mechanical. On a line shaft drive the motor was required to drive fifteen machines, where in reality there is never more than eleven being used at one time. The motor has never carried full load. This is not an exceptional case, it is a case that can be found in many places.

Why don't the electrical men get together? How can we make them step forward? It's a big proposition that will be solved soon, and very soon it will be a forced issue. Soon we will step to the front; we will be called to assert ourselves. Then will we be ready?

JAMES F. COEN.

New Books

Direct-Current Machinery—By Harold Pender, 314 *pages, illustrated,* 6 *in. by* 9 *in., bound in cloth. Published by John Wiley & Sons,* 432 *Fourth Avenue, New York, N. Y. Price* $3.00.

The author has prepared this book without going into details of design to such an extent as to be confusing to the ordinary undergraduate student, as in his knowledge there is no text book on direct-current machinery which gives a thorough treatment of the theory and performance of such machines. The text presents the theory of direct-current machines and much space is given to the performance, application and testing of the various types of direct-current generators and motors. The testing methods given are those commonly used in commercial laboratories and by manufacturing companies.

The Dynamo, Its Theory, Design and Manufacture, Vol. 1.—*By C. C. Hawkins,* 6*th Edition,* 615 *pages, illustrations and diagrams,* 6 *in. by* 9 *in., cloth. Published by Isaac Pitman & Sons, London and New York. Price* $6.00.

A standard British text of comprehensive character, covering both direct and alternating current generators. The book has been largely rewritten and carefully revised.

Car Lighting Maintenance Methods on the Erie

Systematic Record Keeping Prevents Any Car from Being Slighted at Regular Inspection and Greasing Periods

REGULARITY in greasing and in inspection of car lighting equipment is unquestionably one of the first requisites for its successful operation. These things are accomplished on the Erie Railroad by the inauguration of a system of record keeping by means of which it becomes practically impossible for any car to be neglected without that fact being known at headquarters.

Greasing and Overhauling Report.

Station ________ 192

Car No. ____ Generator No. ____ Armature No. ____

Type of Generator ____ Make of Bearing ____ Last Greased ____

Defects Found ____

Repairs Made ____

NOTE:—All new material applied on this car to be shown on Form 801 in regular way.

________ ELECTRICIAN.

Form A—This Form is Made Out for Each Overhauling; the Original is Kept in the Jersey City Office and Duplicate is Sent to the New Haven Office. This Report Supplies the Information for Keeping the Record of Greasing and Overhauling Shown in Form F

The car lighting maintenance on the Erie is carried on by the Safety Car Heating & Lighting Company on a contract basis, and many of the reports are sent in duplicate to the general foreman's office in Jersey City and to the main office of the company in New Haven. For maintenance purposes it has been found that it is desirable to separate the cars into two classes according to a mileage basis. By this arrangement those cars which operate over 150 miles daily are grouped in one class and those which operate less than 150 miles are considered in another class. It is obvious enough that such an arrangement is really advantageous as cars which operate through the greater distances naturally should be given more consideration than those which are not placed in the same strenuous service.

In handling the maintenance work, it is believed that the best results are secured by making daily inspections of all those cars which travel more than 150 miles per day. These cars are spoken of as through line cars. Other cars which go away for 10 or 12 days or more receive a thorough inspection each time they arrive at Jersey City. The Erie operates a great many suburban trains, and the monthly mileage of some of the cars in this service is considerable. Under such circumstances, quite a number of the suburban cars are properly classified as through line cars even though their runs may be confined almost exclusively to local territory.

Greasing and Overhauling

A record of the greasing and overhauling of the cars is kept upon a chart in the office at Jersey City. This chart is known as the Greasing and Overhauling List and upon it certain months of the year are set apart for different kinds of work to be done upon the cars. January, February and March are designated as the months of overhauling while during April and May the work is planned to be confined to greasing only. From the first of June up to the end of the year constitutes another overhauling period.

SAFETY CAR HEATING & LIGHTING CO. — NEW HAVEN, CONN.

RAILROAD ____ STATION ____ 192__
REPORT OF INSPECTION OF AXLE LIGHT EQUIPMENT

TRAIN NUMBER	CAR NAME OR NUMBER	GENERAL DESCRIPTION OF EQUIPMENT AND REPAIRS MADE

STATION ____ 192__
REPORT OF MATERIAL USED

CAR NAME OR NUMBER	QUANTITY	CATALOGUE NUMBER	DESCRIPTION OF MATERIAL		

FAILURES

TRAIN NUMBER	CAR NAME OR NUMBER	CAUSE OF FAILURE

READ INSTRUCTIONS ON BACK

SIGNED ____ INSPECTOR

Form B—This Form is Made Out Daily for All Cars Inspected or Overhauled. All Trouble is Reported in Detail at the Bottom of the Form

The months of September, October and November of this period are assigned for the overhauling of the through line cars, and at this time pulleys, belts, generators, panels, etc., are given a thorough overhauling. It will be seen from the chart that the numbers of the various cars appear under the headings of the different months, and when any particular month has ended each car on the list should have a check after it showing that the work designated for that period has been performed. In the event that no check mark appears after the car number, investigation is immediately made, and after it is found that the work has not been done in accordance with the prescribed program, steps are taken to see that the proper attention is given to the car at once. The greasing and overhauling list is kept up to date by the various reports sent in from the electricians along the road, in whose territory the different cars are operated. These men make their reports on blank forms known as greasing and overhauling reports.

During the months of April and May when only greasing is being done, another blank form is used by the electricians which bears the heading of Ball Bearing Inspection and Greasing Report.

Suburban Coaches

Suburban coaches which travel less than 150 miles per day get partial inspections every day, and every 15 days they receive a thorough inspection. At this latter inspection pulleys, belts, and parts of generators, regulators, etc., are thoroughly gone over and all light repairs are made. Any heavy repairs that appear at this time are reported to the tool men who proceed to put the cars in first class condition. In this way troubles are kept down to a minimum, for in going over the cars every 15 days small troubles are prevented from becoming big ones.

Care of Batteries

All of the batteries used in the Erie service are of the Edison type. For this reason, the usual battery house, with its various operations and its numerous appurtenances which are so important to the handling of lead batteries, as absent from the Erie maintenance program. In the care of Edison cells, one man, who is really a helper, is assigned the duty of cleaning the top of the batteries and oiling the caps every 60 days. A report of this work is made on the same form as is used for the inspection. Every three years it is the practice to remove the batteries from the car and dip both cells and crate in Esbelite, which is a black enameled finish used as a preservative. For this purpose, a tank lined with sheet iron was built sufficiently large to take in a tray of any size. The tank is filled half full with Esbelite and the trays lowered by means of a chain hoist until the paint rises to the top edge of the container. The cells are then raised out of the liquid and rolled away on an overhead rail to a dripping pan. The entire process requires approximately 15 minutes to perform. During the period that the batteries

SAFETY CAR HEATING & LIGHTING CO.

CORNER DIXWELL & PUTNAM AVENUES

NEW HAVEN, CONN.

BALL BEARING INSPECTION AND GREASING REPORT

__________ Station, for Month ending __________ 19

Date	Car	Make	Condition of Bearing and Grease	
			Pulley End	Front End

Signed __________

Form C—Form Used for the Greasing and Inspection of Ball Bearings Only. Bearings Are Not Removed. This Form Furnishes Information to be Included in Form F

are out of the cars receiving this treatment, a capacity test is run on them in order to see how the regulators are taking care of the batteries in service. The results of this test are also tabulated on a special form which includes such information as battery number, space, type, whether battery is new or old, gravity, kind of solution, temperature, discharge rate, etc. The usual procedure in making a capacity test is to discharge the battery through a rheostat, taking readings every hour until the voltage has dropped to 1.1 volt. The battery is discharged at the 8-hour rate. If the battery has been found to have 100 per cent of this rated capacity or nearly so, it is charged at the 7-hour rate with an overcharge of 20 per cent and then put back in service. If, however, a battery is found to be very much below its rated capacity, it is charged at the 7-hour rate with 20 per cent overcharge and another

BATTERY FLUSHING CHART

YEAR 1922 STATION JERSEY CITY

CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
170													893													1026													1092												
555													894													1027													1093												
599													895													1028													1094												
607													896													1029													1117												
608													897													1030													1118												
609													898													1031													1119												
614													900													1032													1120												
615													901													1033													1122												
618													902													1034													1130												
625													948													1035													1131												
626													949													1036													1132												
627													952													1037													1133												
629													953													1038													1134												
630													954													1039													1199												
631													955													1040													1212												
646													956													1041													1239												
655													957													1042													1266												
689													958													1043													1293												
690													959													1044													1294												
691													960													1045													1296												
692													961													1046													1304												
693													962													1047													1357												
694													963													1048													1385												
695													966													1049													1392												

CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	CAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1873													1948													2054												
1877													1949													2055												
1881													1950													2056												
1885													1951													2057												
1886													1952													2058												
1887													1953													2059												
1888													1954													2060												
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1894													2000													2066												
1895													2001													2200												
1896													2002													2201												
1897													2003													2202												
1898													2004													2203												
1899													2005													2204												
1900													2006													03098												
1901													2007													03099												
1902													2008													973												
1903													2009													974												
1904													2010													975												
1905													2011													976												

Form D—The Battery Flushing Chart Used to Record the Flushing and Inspection of Batteries. This is Carried on Throughout the Year and If Any Car Shows Neglect Those Responsible Are Readily Traced

test is made. After this has been done and it is still impossible to get the rated capacity from the battery on discharge, it is charged once more. If two or three trials fail to bring the battery back to its rated capacity, it is sent to the factory for repairs.

A record of battery inspection and flushing is kept in the office at Jersey City on another chart known as the Battery Flushing Chart. This chart contains the numbers of all of the cars which are electrically equipped and is provided with spaces opposite the various months of the year in which to indicate whether or not the cars have received the proper attention. The regular battery flushing and inspection is planned to be made twice each month. A small check mark is used to indicate that the battery is flushed and a small x to indicate that no flushing is needed.

SAFETY CAR HEATING & LIGHTING CO.

COR. DIXWELL & PUTNAM AVES
NEW HAVEN CONN

BATTERY INSPECTION AND FLUSHING REPORT________________STATION

Note:– In column 4 use ✓ to indicate Battery Flushed and X to indicate no need of flushing. If level of electrolyte is below top of plate, give distance in inches in column 4. In column 5 indicate condition as good, fair, poor, with number of dead cells, if any

1 Date	2 Car No.	3 Battery No.	4	5 Condition	1 Date	2 Car No.	3 Battery No.	4	5 Condition

This report to be filled in from day to day and mailed to general office on the 1st and 15th of each month. A carbon copy to be retained as plant record

Date ________________ Signed ________________

Form E—This Form Is Made Out By the Battery Inspector on the 15th and 31st of Each Month. It Furnishes the Record for Form D

The battery flushing chart is kept up to date by reports which are sent in from the electricians along the road.

GREASING AND OVERHAULING LIST

YEAR______ INDICATE WITH ✓ MARK AFTER CAR NUMBER WHEN WORK IS COMPLETED

OVERHAULING			GREASING ONLY				OVERHAULING									
JAN.	FEB.	MAR.	APRIL		MAY		JUN.	JUL.	AUG.	SEP.		OCT.		NOV.		DEC.
884	888	802	170	977	1027	1071	801	892	865	170	977	1000	1046	1055	1133	800
887	897	885	599	978	1028	1072	803	986	883	599	978	1001	1047	1056	1134	886
981	1820	896	689	991	1029	1073	889	1838	890	689	991	1002	1048	1057	2200	894
1808	1914	1117	690	992	1030	1074	895	1840	891	690	992	1003	1049	1058	2201	900
1809	1919	1118	691	993	1031	1075	988	1847	893	691	993	1004	1050	1059	2202	901
1810	1923	1119	692	994	1032	1076	1293	1849	898	692	994	1005	1051	1060	2203	902
1811	1926	1120	693	995	1033	1077	1294	1853	985	693	995	1006	1052	1061	2204	987
1812	1929	1800	694	996	1034	1078	1825	1860	1871	694	996	1007	1053	1062		1896
1886	1932	1801	695	999	1035	1079	1826	1905	1873	695	999	1008	1054	1063		1897
1887	1943	1802	696	1000	1036	1080	1830	1909	1881	696		1009		1064		1901
1888	1946	1803	697	1001	1037	1081	1832	1915	1885	697		1010		1065		1902
1889	1948	1804	698	1002	1038	1082	1834	1916	1921	698		1011		1066		1907
1891	1949	1805	699	1003	1039	1083	1835	1933	1930	699		1012		1067		1927
1893	1954	1806	700	1004	1040	1084	1890	1938	1936	700		1014		1068		1928
1894	1957	1807	701	1005	1041	1085	1892	1941	1945	701		1015		1069		1935
1895	1958	1818	705	1006	1042	1086	1900	1942	1953	705		1016		1070		1951
1898	2000	1819	706	1007	1043	1087	1903	1944	1955	706		1017		1071		2015
1899	2007	1821	707	1008	1044	1088	1904	2006	1956	707		1018		1072		2017
1906	2008	1822	708	1009	1045	1089	1910	2014	1959	708		1020		1073		
1908	2009	1823	709	1010	1046	1090	1918	2018	2001	709		1021		1074		
1917	2016	1824	710	1011	1047	1091	1920	2019	2002	710		1022		1075		
1924	1813	1911	711	1012	1048	1092	1922	2020	2004	711		1023		1076		
1934	1814	1912	712	1014	1049	1093	1925	2021	2005	712		1024		1077		
1950	1815	1913	713	1015	1050	1094	1937	2022	2010	713		1025		1078		
2012	1816	1931	714	1016	1051	1097	1939	2023	2011	714		1026		1079		
2013	1817	1947	715	1017	1052	1130	1940	2024		715		1027		1080		
			716	1018	1053	1131	1952			716		1028		1081		
			717	1020	1054	1132	2003			717		1029		1082		
			718	1021	1055	1133				718		1030		1083		
			719	1022	1056	1134				719		1031		1084		
			948	1023	1057	2200				948		1032		1085		
			949	1024	1058	2201				949		1033		1086		
			952	1026	1059	2202				952		1034		1087		
			953	1025	1060	2203				953		1035		1088		
			954		1061	2204				954		1036		1089		
			955		1062					955		1037		1090		
			956		1063					956		1038		1091		
			957		1064					957		1039		1092		
			958		1065					958		1040		1093		
			959		1066					959		1041		1094		
			960		1067					960		1042		1097		
			961		1068					961		1043		1130		
			962		1069					962		1044		1131		
			963		1070			03098	03099	963		1045		1132		

Form F—Each Station is Supplied With This Form Which Is Kept Up to Date From Information Reported on Form A

The reports of these electricians are made out on the blank forms from day to day and mailed to the general office on the first and fifteenth of each month.

Suspension Pin Lubrication

The lubrication of generator suspension pins is accomplished in a somewhat unusual manner. Every spring for one month the only lubrication used on these pins is kerosene oil. The time set apart for this application is the month of April. The kerosene is applied in order to cut down any rust that may have formed, and at the end of this cleansing period the pins are lubricated with dynamo oil once or twice each month. If any pin is found to be sticking, the dirt or rust is removed by applying pressure by means of air hose connected to the end of the filler cup after the cup has been filled with kerosene. In this way it is possible to drive out any rust that may have formed.

Electric Traction Recommended for Temiskaming & Northern Ontario

Electric traction was recommended for the Temiskaming & Northern Ontario Railway in a report recently prepared by S. B. Clement, chief engineer, T. & N. O. R., and J. G. Kerry, consulting engineer, T. & N. O. R. The report was made to the Commission in charge of the operation of the railway and was transmitted by the Commission to the Government of the Province of Ontario. The Commission's engineers did not definitely recommend the immediate electrification of the railway but rather recommended electric operation as adequate and desirable from engineering and operating standpoints. Electric traction was recommended as a reliable and economical system of operation for the main line, for the Iroquois Falls and Porcupine branches and for other branch lines where the traffic has been sufficiently developed to justify the additional capital investment involved. The sections for which electric traction was recommended include the main line from North Bay to Cochrane, 252.3 miles, the Iroquois Falls subdivision, 7 miles, and the Porcupine subdivision, 33.1 miles.

The Commission's engineers reported that from an operating standpoint electrification would be entirely satisfactory and on the basis of operating and traffic statistics for the year 1921 estimated the cost of electrification. The resulting decrease in operating expenses was found to be in excess of interest charges on the additional investment required. The estimates were all based on 3,000-volt direct current operation, although at this stage of the investigation, the Commission has not definitely discarded the possibilities of high voltage alternating current systems.

Cost of Coal Is $9.50 a Ton

A favorable showing for the electrification of the T. & N. O. was due largely to the comparatively high cost of locomotive fuel and the availability of hydro electric power. In the super power commission report, estimates for railway electrification were based on coal at $5 per ton on the locomotive tender and electric power at one cent per kw. hr., while on the T. & N. O. the average cost of coal is $9.50 per ton and hydro electric power can be generated and delivered for less than one cent per kw. hr. This relatively cheaper energy enabled electrification to make a favorable showing on the T. & N. O., notwithstanding a traffic density less than is usually required for favorable results from electrification.

Cost of Electrifying

The estimated cost of electrifying the line to give it a capacity to handle the expected 1925 traffic, calculated at

25 per cent greater than that handled in 1921, was reported as follows: Railway transmission system, 312 miles of 66,000 volt line, $1,279,200; railway substations, 7—1,500 kw. automatic, $735,000; 2—1,500 kw. manually operated, $190,000; 1—3,000 kw. manually operated, $165,000; 1—1,500 kw. portable, on 2 cars, $90,000; power indicating and limiting device, $62,500; 3,000 volt d. c. power distributing system, overhead feeders and bonding, 410 miles, $2,740,000; twelve 150-ton freight locomotives, $1,800,000; five 150-ton passenger locomotives, $750,000; nine 80-ton switching locomotives, $774,000; 10 heater cabs, 43 tons, light, $275,000; gasoline motor repair car for overhead work, $25,000; cost of power development as estimated above, $3,229,078; less salvage value of released steam equipment, $900,000; total cost, $11,214,778.

Steam and Electric Operating Costs Compared

The report compared the actual cost of operation in 1921, with steam locomotives, with the estimated cost of operation with electric locomotives, those items affected by the type of power used comparing as follows: A., with steam power: Water station maintenance, $11,375; fuel station maintenance, $2,495; water, $31,947; locomotive repairs, $307,103; locomotive house expense, $141,985; locomotive depreciation, $21,288; fuel for locomotives, $817,845; hire of freight cars for transporting locomotive fuel, $13,133; transportation of locomotive fuel on T. & N. O., $66,567; total, $1,413,378. B., with electric power: Water, $250; transmission line maintenance, $24,960; substation operation, $37,000; substation maintenance, $12,500; power distribution system maintenance, $63,000; locomotive repairs, $167,130; locomotive house expense, $37,140; locomotive depreciation, $60,480; electric power supply, operation and maintenance, $96,872; coal for heating passenger cars, $13,000; heating tenders, repairs and maintenance, $18,500; wages, heater tender firemen, $16,650; heater tender depreciation, $5,500; total, $552,982. Balance in favor of electrical operation, $860,936; capital cost of electrigcation, $10,914,778, this being $300,000 less than above estimate for 1925 traffic, on account of two less freight locomotives being required; rate of interest earned on investment, 7.89 per cent.

The report then compared the costs of operation on the basis of the supposed 1925 traffic, and found a saving of $1,049,596 in favor of electrical operation, or at the rate of 9.35 per cent on the estimated capital cost of $11,214,778. It then compared the costs on the basis of a traffic 50 per cent greater than that handled in 1921, and found a saving of $1,249,738 in favor of electric operation. On a capital cost of $12,105,778 (the increase in capital cost being due to the acquisition of three more freight locomotives, two more passenger locomotives, one more switching locomotive, and two more heater tenders, on account of the increased traffic), that saving would represent a return of 10.31 per cent.

The engineers recommended that the study of detail engineering practice be continued and that plans and specifications for electrification and for power development be completed so that actual tenders for all work involved may be obtained.

The T. & N. O. R. Commission, in presenting the report to the Ontario Government, recommended that electrification be postponed at least for the present time and the Government issued authority for continuing investigations.

The capital funds required by the T. & N. O. R. are provided by the Government from the consolidated revenue of the Province. The electrification project has apparently received very favorable consideration, but it is quite possible that prior demands upon the revenue of the Province may make it inadvisable to proceed immediately with the undertaking. At the present time the investigations are being continued, particularly in respect to the available sources of hydro electric power.

Palais Station, Quebec

Observations on Electric Railway Practice*

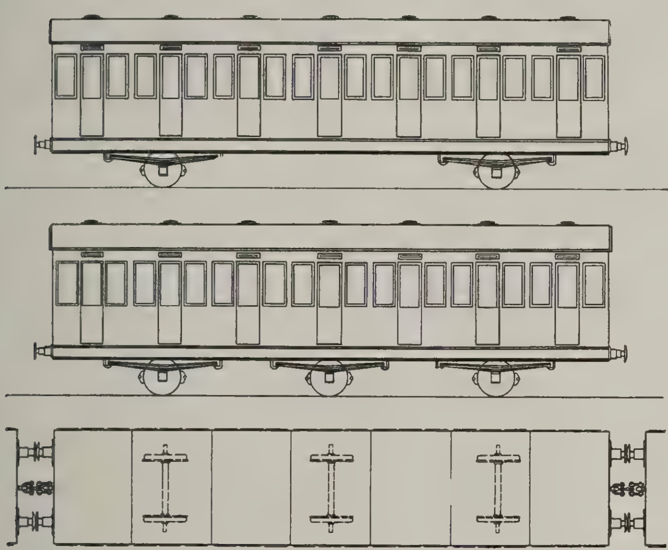
A Comparison of Practices and Developments in the United States and European Countries

By W. B. Potter

Engineer, Railway Engineering Department, General Electric Company

THE development of rail transportation since the day of stage coaches and horse-drawn tram cars has been a process of evolution in which some reminders of the past are still noticeable.

Before the days of steam the track gage used for the tram cars of the British coal mines was presumably the origin of the odd dimension of 4 ft. 8½ in., which has become so generally accepted as the standard track gage of the railroads of today. In Great Britain freight cars are still called "waggons," and many of the older passenger vehicles there and on the continent are a sort of multiple-unit stage coach in arrangement and interior fittings. These passenger coaches are much as if several coach bodies were mounted on a flat car, and to carry out the illusion, the exteriors of the separate compartments are sometimes so paneled as to resemble the outlines of a coach. The doors, windows and the interior are as nearly like the old stage as one could imagine, not omitting the looped strap arm-rest for those sitting at the ends of the seats.

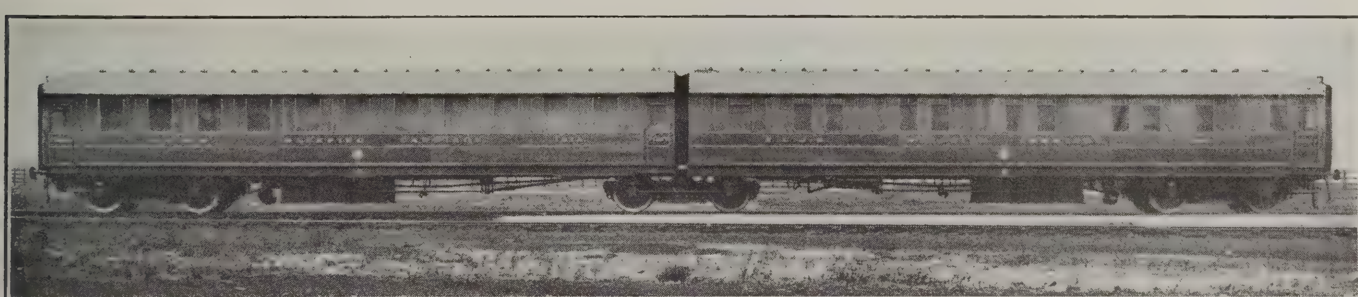


Side Elevations and Plan of Two- and Three-Axle Cars Weighing from 20 to 23 Tons, Used on European Railways

The modern European passenger cars although retaining the compartment plan are usually provided with a corridor throughout and vestibuled passage between the cars. These cars are well equipped, comfortable and afford a privacy which we do not enjoy without extra price.

Our first electric cars were converted horse-cars, and in keeping with their previous motive power there was at first a disposition to use much smaller motors than were suitable. About one-and-one-half horsepower was probably a fair average for the old horse-car; and where two horses had served, an equipment of two 10-horsepower motors seemed out of proportion despite the consequent improvement in schedule.

The single truck of the old horse-car was not suitable for the higher speeds and longer car bodies soon called for in electric service. The bogie or double truck motor car so generally used today was a natural adaptation from steam railway practice, and the simplicity of this design was early appreciated as advantageous for electric locomotives. One of the first electric locomotives used in regular service in this country was an electrically equipped bogie truck railway express car. The motor car practice of mounting geared motors directly on the axle has been quite generally applied and has proved very satisfactory for electric locomotives. In Continental Europe the development of the electric locomotive seems largely to have been carried out with the idea of substituting the electric motor for the steam locomotive cylinder and retaining the steam locomotive feature of connecting rod drive.



An Articulated Sleeping Car Used on the Great Northern Railway of England

While there is a similarity in the character of traffic and conditions under which it has to be carried on in the European countries, there is a great difference in these respects between Europe and this country. The influence of precedent, experience and individual opinion under these quite different conditions has naturally led to a different viewpoint and to some differences in practice

*Abstract of a paper presented at the eleventh Midwinter Convention of the American Institute of Electrical Engineers at the Engineering Societies Building, New York, February 14, 1923.

between this country and Europe. There is much to commend and little to criticise in the railway practice and equipment as it exists in the different countries. Each country has endeavored to provide transportation of a character most suitable for its particular requirements. Occasional visits to any country do not give opportunity of becoming well informed on this subject comprehensively, but even casual observations, as in this instance, may serve as an excuse for comment and comparison.

European and American Rolling Stock Compared

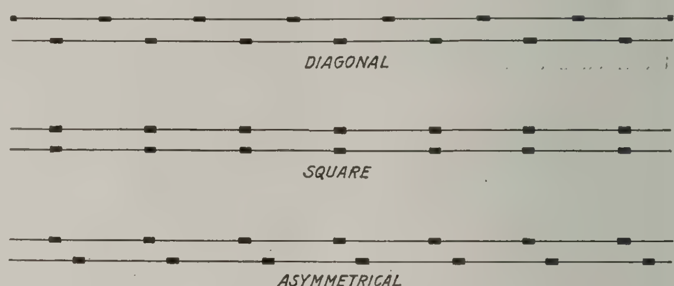
The weight of European freight trains and the maximum draw-bar pull allowed are about one-quarter of what they are in this country. The weight of their passenger trains is about one-half. The permissible weight on driving wheels is about two-thirds and the weight per axle of their cars is about one-half of our usual practice. The low draw-bar pull and car weight permit a relatively light mechanical design of rolling stock, and the requirements as to strength are further made easier by the method of car coupling.

The screw coupler, i. e., two clevises connected by a rod with a right and left-hand thread is used almost universally. Each draw-bar has a hook that is provided with a screw coupler, and in the process of coupling the clevis of one of the couplers is thrown over the hook of the other draw-bar, and the cars in effect are jack-screwed together by hand. There are two mushroom-shaped buffers with faces about one foot in diameter, the right one having a rounded face and the left hand a flat face. These are located near the corners of the car. The initial tension on these buffers is about 2,000 lb., and when fully compressed the pressure is approximately 20,000 lb. As might be expected, there is ordinarily no shock when coupling with this kind of a coupler as a slight compression of the buffers is all that is required. With our automatic couplers the shock of coupling is occasionally in the nature of a crash.

Admitting the advantages of the automatic type of coupler, the use of the screw coupler does permit a much lighter end framing on locomotives and cars. An inquiry as to European experience with automatic couplers brought forth the comment that the couplers were all right, but that the process of coupling wrecked the rolling stock. Allowing for various requirements, the weight of European electric locomotives is from two-thirds to three-quarters the weight of electric locomotives in this country having the same horsepower.

The speed of European trains on the average is rather higher than in this country. Any of the European cars have two or three axles which does not seem to be a wheel arrangement that would provide for smooth running. In many instances these cars have no truck framing, but depend upon the car springs to hold the axles in alinement. These springs are usually about 6 ft. long and semi-elliptical in shape, although so little curved as to be nearly flat. The springs bear directly on the journal boxes and are so resilient that the vertical shock from track joints is very well cushioned. The shorter wheelbase two-axle car and many of the three-axle cars have a tendency towards transverse oscillation, which may be decidedly uncomfortable unless the cars are properly coupled together. The combination of the screw coupler and buffers has more influence in steadying the car and preventing oscillations than might be supposed. When the coupling is set up sufficiently to compress the buffers, the friction between them is sufficient to prevent any relative movement so that each car is steadied by the one to which it is coupled.

On a fast train made up of similar cars having two four-wheel trucks, there was a noticeable difference in the riding qualities of those cars on which the couplers had been screwed up and certain others so loosely coupled that the buffers did not touch. It is the usual practice to screw up the coupler sufficiently to compress the buffers, but there are exceptions. A remembered instance was a trip on a two-axle car of about 14-ft. wheelbase which was loosely coupled to the rear end of a passenger train. At a speed of about 55 miles the transverse oscillation, or "side slogger" as it has been called, was so bad as to cause some apprehension to the uninitiated. At the first stop the coupling was screwed up, which was all that was necessary to effectually check the "slogging." The frequency of these transverse oscillations appeared to be the natural period of the car body as established by the scheme and proportions of its flexible supporting structure. The track did not seem to induce any supplemental oscillation.



Different Plans for Locating Track Joints to Illustrate Effect on Transverse Oscillations of a Car

Track Construction

The method of locating track joints perhaps has more influence on the running quality of the rolling stock than is commonly appreciated. The European practice is to lay the track with square joints, i. e., with the joint of each rail directly opposite. The customary practice in this country is to lay the track with joints spaced diagonally (staggered) and located midway between the opposite rail The trial run of an electric locomotive over a track with square joints, which were in poor condition, afforded an exceptional opportunity to observe the reaction of a track with this arrangement of joints. This locomotive had bogie trucks and at about 60 miles an hour there was a very decided vertical vibration, but no tendency whatever toward enforced side oscillation. With diagonally laid joints, in as poor condition, it is questionable whether any locomotive or car could have been run at that speed without something giving way; particularly if the transverse oscillation, which is diagonal in direction relative to the track, had happened to synchronize with a diagonal location of the low joints. Only one railway in Europe was noted where the rails were laid with diagonal joints. The manager remarked that his electric motor cars were subject to so much oscillation that it was his intention to relay this track with square joints.

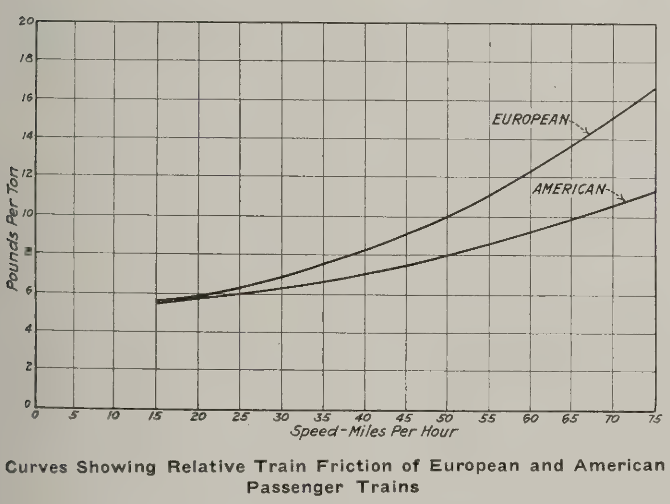
A comparison of the influence of square and diagonal joints on the running qualities of a motor car was recently observed in this country over a line having both kinds of joints. On the portion of track having square

joints there was observed a slight steady oscillation of uniform character at the rate of about 150 per minute; on the portion of track with diagonal joints the same car did not oscillate with equal steadiness and at times had a noticeable swing toward one side or the other. As the car was running at about 60 miles per hour, the natural period of oscillation did not correspond with the location of the diagonal joints. Had the vibration synchronized with the joints, an enforced and increased oscillation might reasonably have been expected. This particular track was in good condition throughout.

There is no doubt that track laid with square joints is more difficult to keep up as the impact on the ballast is more severe when both wheels strike the joints simultaneously. With the less weight per axle customary in European practice, it is much easier to maintain the track than it would be with our heavier weights per axle.

The writer suggests that it might be possible to secure the advantage of diagonal joints in respect to track maintenance and the steadier running quality of square joints by laying the track with joints asymmetrically spaced, that is, instead of overlapping a half rail length, to overlap between one-quarter and one-third, preferably a length of lap that would not be an even fraction of the rail length.

On the Great Northern Railway, England, an articulated arrangement of cars into groups is used, which is a departure from the conventional car with two four-wheel trucks. This articulation is accomplished by locating a truck midway between each of the several cars in the unit group, so that the number of trucks is only one in excess of the number of cars constituting the group. In the suburban service the trains are composed of two groups each of four cars, this requiring 10 trucks for the eight cars.



Curves Showing Relative Train Friction of European and American Passenger Trains

On the main line the train is made up of a number of individual cars and a five-car articulated group. The reduction in weight, as compared with two bogies for each car, is said to be about 10 per cent; it is also stated that the train friction is reduced. A noticeable feature on the main line train at high speed is the smooth running of the group; the riding is exceptionally good and noticeably better than individual cars in the train.

Types of Drive for Electric Locomotives

In the brief reference to electric locomotives, the motor car and steam locomotives were mentioned as prototypes which have influenced the trend of electric locomotive development. To elaborate, there are at least seven methods, including the way of mounting motors and the mechanism for transmitting power from the motors to the drivers, which have been applied to actual service. These different methods may be briefly described as axle geared, quill geared, outside geared, axle gearless, quill gearless, direct connected side rod and geared side rod.

Each of these methods of drive, with the exception of the outside gear, are employed in this country. In England the axle geared drive has been most generally used, but there has been completed recently a high speed locomotive for the North Eastern Railway equipped with the quill geared drive. The side rod drive does not seem to have met with favor; the following reference to side rod is quoted from a paper by Sir Vincent Raven (North East Coast Institution of Engineers and Shipbuilders, December 16, 1921):

> "On the Continent, notably in France, Switzerland, Italy, Germany, Austria and Sweden, the connecting rod drive in one form or other is almost universal. Up to the present, electrification in these countries has been carried out mainly on the single-phase or three-phase system and Continental engineers consider that the additional complications caused by the introduction of cranks and coupling rods are more than compensated for by the advantage of having a free hand with the motor design.
>
> "A large number of designs have been worked out. Some have proved quite satisfactory, others have given rise to a good deal of trouble. In most cases the trouble has been eliminated by strengthening of special parts such as crank pins, Scotch yokes, etc., and by introducing a certain amount of flexibility into the connections between the motors and the crank shafts."

The mechanism of the motor-driven side-rod drive needs to be maintained in close adjustment and may reasonably be expected to require more attention and have a higher cost of maintenance than some of the other methods of transmitting power to the drivers.

The transmission of power from a motor-driven crank, whether direct connection or geared, introduces strains in the connecting mechanism somewhat different from those which occur in a steam locomotive. With the best adjustment and operating clearance only in the bearings, the motor-driven connecting rods on either side transmit alternately the power through 90 degrees, except for such spring of the parts as may cause the rods to work together for a brief interval. As this transfer of the power from one rod to the other takes place at about 45 degrees from the dead center, the pins, connecting rods and included frame will be subjected to the full strain of driving when the crank is at an angle of about 45 degrees. If the two sides are not in even adjustment this angle may be even less.

Aside from centrifugal forces and the shock due to lost motion in the driving mechanism, the stress in the rods, pins and frame of a steam locomotive is limited and may be predetermined from the size of the cylinder and steam pressure. With a motor driven crank the stress is dependent on the crank angle and is affected by adjustment of the mechanism.

As an extreme illustration, one side of a steam locomotive may be stripped and with the other side on dead center the throttle may be opened wide without damage to the locomotive. Under the same conditions with a motor-driven crank, the resultant toggle action would set up enormous stress and undoubtedly wreck some part of the mechanism involved.

There is, further, an irregularity in the angular rotation of the crank with respect to the wheel which is the cause of superimposed stress on the driving mechanism, and may be the cause of very disagreeable vibration

should the natural period of the rotating mass involved happen to synchronize with the nodal points of angular variation. The effect of this irregularity in relative uniformity of rotation of the crank and wheel are more in evidence in some forms of side-rod drive than others. The most severe case observed was on a direct connected locomotive with a V arrangement of connecting rods which ran with but little vibration, except at the critical speed, when a knock developed which sounded as if the crank shaft was broken or being struck by a steam hammer. As this irregularity is due to the play in the bearings and the springs in the parts, it cannot be entirely eliminated in practical operation, but it may be minimized by maintaining the alinement and close adjustment of the bearings. It is obviously desirable to diminish the shock by cushioning as much of the rotating mass as possible.

Something of these characterizations of side-rod drive are shown in one of the illustrations. To better illustrate the action, the mechanism is assumed to be inelastic, the pin bearings of the rods are shown with exaggerated clearance, and the ordinates of the characteristic curves are greatly out of proportion. Fig. 2 in the last illustration shows the change in angular position of the crank with respect to the wheel and Fig. 3 shows the angular velocity of the crank with respect to the wheel.

In reality, the value of these ordinates is dependent upon the working clearance in the bearings, together with the inertia of the rotating masses and whatever may be their actual value, the character of the action calls for its consideration in the design of side-rod mechanism. Furthermore, the arc of action and the sharp angles of the characteristic curves as shown would be modified by the spring in the connecting parts.

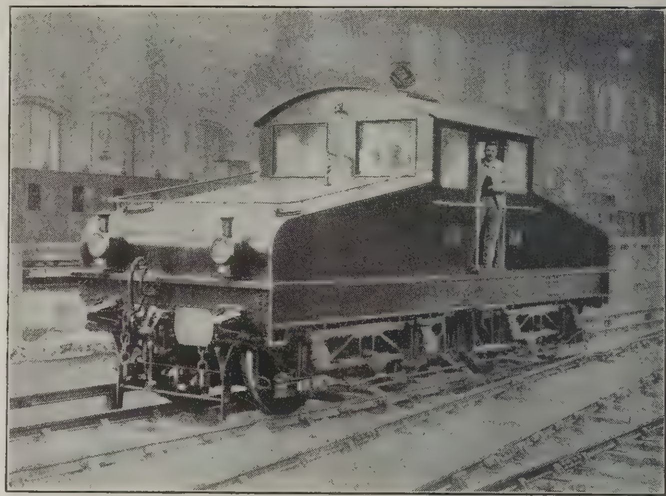
There appears to be an increasing interest on the Continent in other methods of drive requiring less attention and maintenance. The Paris-Orleans Railway has been operating axle-geared locomotives in their Paris Terminal for more than twenty years and have recently ordered 200 of this type for local passenger and freight service on their main line extension. Over 100 of similar type are being built for the Midi and the State Railways. Locomotives with the same type of drive are also being built for the Spanish Northern Railway.

The electric locomotives on the Italian Railways are mostly of the direct connected side rod type. The workmanship and finish of these locomotives is exceptionally fine, so good, in fact, from our point of view, that we might consider it an extravagance. They are well maintained, are giving good service and many others have been built from the same design.

The electrification of the railways in Switzerland has been very well carried out, and they may well take pride in their construction and equipment. The Swiss Railways have a variety of locomotives which are principally of the geared side rod type. The finish and workmanship of these locomotives is excellent, and they are very fine examples of geared side rod construction.

An interesting departure from side-rod drive is a novel design of outside geared drive.* This locomotive runs very smoothly without any characteristic vibration, and the more general use of this type of drive on the Swiss Railways may reasonably be expected. These railways have also in trial service a number of locomotives with geared quill drive.

European motive power equipment is generally of more elaborate finish and gives the impression of being better maintained than is customary with us. An instance is recalled of two steam locomotives which were double heading on the London and North Western. One of these locomotives was built in 1897 and the other in 1867. They were polished and varnished with equal care and had every appearance of being of the same vintage until one observed the date label, and that the older locomotive had only one pair of drivers while the other had two. As an illustration of the greater attention given to details it is customary on many of European railways to equip both steam and electric locomotives with a speed indicating and recording instrument. The record obtained is very complete, showing the speed at all times during the run, distance covered, time of the run and the location and duration of the stops.



One of the Axle Geared Locomotives Which Has Been in Service in the Paris Terminal for 20 Years

Brakes

The braking equipment of European trains is quite different from our almost universal practice. Their passenger trains are equipped with power brakes of either the vacuum or pressure type and usually with two brake shoes per wheel. As there are several different braking systems in use, it is necessary in some instances to equip through cars, which run over different railways, with more than one system. In the trans-European service to Constantinople, it is said that each car has to be equipped with four different braking systems to conform with the regulations en route.

Power brakes are seldom used on the freight trains and some of the freight cars have no brakes whatever. In many of the freight yards there will be found wooden wedges, which are for the purpose of chocking the wheels to hold the cars in place. The hand brake attachment to the braking system is usually through a screw and nut, instead of the chain and brake staff we commonly use. In some instances the brakes are applied only by a lever extending alongside. To handle freight trains on grades, where the brakes are necessary to control the speed, it is customary to provide a brakeman for every four cars. In ordinary freight movements the braking is done entirely with the locomotive.

*Described in the January, 1923, sisue of the *Railway Electrical Engineer*, page 20.

Current Collection

The sliding contact for current collection from overhead lines is almost universal on the Continent, for both tram cars and locomotives. Two triangular tubes of brass or copper are used for the contact on many of the Italian three-phase locomotives, and triangular blocks of carbon are used on some of the direct current lines; but generally for tram cars and single-phase locomotives the collector is an aluminum bow of U-shaped section with a groove for lubricant.

In locomotive service it is the practice to use two of these bow collectors on each locomotive, and because of the soft material the pressure against the conductor is limited to about 8 lb. With this light pressure, some arcing might reasonably be expected and is observable when collecting from a single wire. In some places two conducting wires with interspaced hangers are used, which is better for current collection than a single wire, as it provides greater flexibility and doubles the collection contacts. Where the double-wire construction has been used there was no observable arcing at the collector. While the aluminum bow serves its purpose well for collecting the 100 amperes or more for which it is used, it would not be suitable for collecting current of any great magnitude.

Collectors of this type would by no means serve for the Chicago, Milwaukee & St. Paul locomotives, on which the current ranges from 800 to 1,200 amperes. The collector used with these locomotives has two separate, flat, copper contact surfaces, while the overhead system has doubled wire conductors with interspaced hangers. This provides four independent contacts in parallel, each of which are 4½ in. long, so that theoretically the aggregate contact is a line 18 in. long. The pressure of the collector against the conductor is about 30 lbs. The

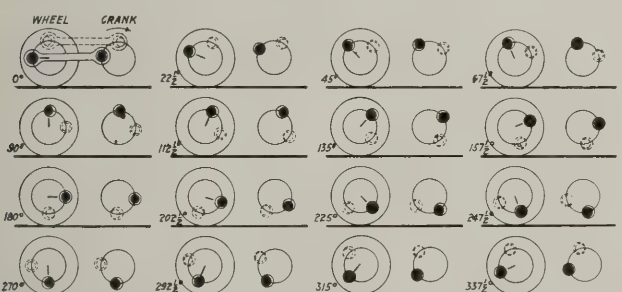


FIG. 1

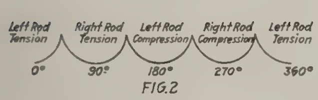


FIG. 2

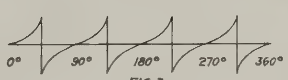


FIG. 3

Diagram Showing the Action of Side Rod Drive and the Effect of Clearance in the Bearings

relatively large amount of current taken by these locomotives is collected with no observable arcing as the continuity of contact is well ensured and the contact surface is of adequate capacity.

Any appreciable arcing at the contact between the collector and conductor is unquestionably more destructive to both than the wear that occurs from mechanical friction. Continuity of contact must be maintained if destructive arcing is to be avoided and the design of the collecting system should be such as will best ensure this continuity.

About One Per Cent of Railroads Are Electrically Operated

The economy in fuel obtained by modern steam power stations and the many available sources of hydraulic power, have contributed to stimulate greatly the electrification of the steam railways in Europe. Government endorsement of the projects has also been helpful in financing these enterprises.

The following list, compiled from available records, will give an idea of the extent of railway electrification throughout the world. It includes the steam railways which have been electrified or are in process of electrification, but not the steam railways on which multiple unit trains are being used exclusively, or electric railways which were not formerly operated by steam.

Steam Railway Electrification

	Route miles	Number of elec. locomotives
United States	1,607	375
Switzerland	661	156
France	602	338
Italy	650	309
Germany	550	49
Sweden	237	44
Cuba	180	18
Austria	340	42
Africa	174	77
Chile	154	42
England	129	12
Spain	48	17
Canada	49	9
Japan	39	42
Norway	39	37
Mexico	30	10
Brazil	26	16
China	25	13
Java	25	5
Total	5,565	1,611

This is less than 1 per cent of the railway route mileage of the world. Conceding the efficacy of the steam locomotive for much of the world's service, there still remains a very large mileage which could be advantageously electrified. In the execution of this great undertaking we have many engineering and economic problems, the solution of which demands the cordial co-operation of all who are engaged in the furtherance of railway transportation.

Entrance to a Spiral Tunnel in the Canadian Rockies on the C. P. R.

Writing for Technical Journals

Why is it that so few men avail themselves of the opportunity to secure prestige and reputation by writing articles for the technical magazines? This question is one which doubtless has quite a variety of answers. In some cases the natural reluctance to write may possibly be given as the reason; in other instances, the lack of time is offered as the excuse. Both of these reasons are no doubt responsible in a measure for the fact that there are comparatively few writers of technical articles. There is still another reason, however, which is probably responsible for the lack of writers. This latter reason is a certain fear that the articles may not be properly arranged to meet the requirements of publication.

It is particularly true that some of the best practical men, those who have had the greatest experience and who, consequently, have the greatest fund of important facts, rarely write for publication. The preparation of a technical article is really a very simple matter as compared with almost any other kind of literary work. There is no plot to be considered; there is no climax to be reached; there is only a simple straightforward presentation of facts in some logical sequence. Of course these facts may be enlarged upon as much as seems desirable in accordance with their relative importance. The type of article considered here is the one which deals largely with the description of engineering installations of some sort rather than one which deals with mathematics. Mathematical articles, while they have their value, it must be confessed that they do not appeal to a relatively large group of readers and for this reason they are not in as great demand as are articles describing the construction or maintenance of some engineering project. Articles of this latter class are certain to be of interest to a much larger number of readers and, consequently, more of them are found in the various trade and technical journals of the country.

Descriptions of engineering construction or maintenance problems, if properly written, give much important information to other engineers, who are thus able to add to their general knowledge on the particular subject discussed.

In preparing such a descriptive article, the writer should be governed by a few simple rules which may be listed as follows:

1. Plan to write your description in a logical order. One of the best ways to do this is to describe the various parts in the same order that they would be shown to anyone visiting the place in person. There is always a logical order in which a visitor would be conducted about any plant or construction job and there is no better way to proceed with the written description of such work than to conduct the reader on an imaginary tour of inspection.

2. In describing the individual parts of a particular piece of machinery or equipment, the important thing to state is why this or that piece of apparatus is required. Tell about its functions, its capacity, and the economies which it will bring about. As a general thing, it is not desirable to make too lengthy a description of any particular piece of equipment, although this is something which will depend upon circumstances. Usually the determining factor is the amount of other apparatus to be included in the story as well as the relative importance of the parts described.

3. One of the most important points for the writer to keep in mind is the character of his reader. While it is essential to give sufficient information to show clearly the connection between the different parts of the story, care should be taken not to bore the reader with a long discussion of details with which he is certain to be familiar. On the other hand the writer must be careful not to assume that the reader has a knowledge of facts which he really does not possess. It is a very easy matter for the writer to omit certain portions of a description because he is so familiar with them that he assumes his reader knows them equally well. This, however, is very often not the case and the result is that the reader is unable to follow the discussion connectedly and loses interest in it.

4. Any article to command the attention of a large number of readers should be properly illustrated. This illustration may be by photographs or drawings and these should be carefully selected so that they will convey to the mind of the reader the correct discussion of the actual object portrayed. In electrical articles, it may be necessary to show some of the circuits used in such classes of work but very complicated wiring diagrams are often better omitted, for, as a general rule, the reader will not take time to study them out. Of course there are important exceptions to this general rule; it depends almost entirely upon the importance of the circuits with regard to the other portions of the article. If the circuit is the main feature of the story, then it could be described at much greater length than would be proper if it only represented a small part of the whole. Photographs are the most desirable means of illustrating the majority of articles, for they possess the inherent quality of reality and are able to give the reader a clearer knowledge of the matter under discussion than he can possibly get in any other way short of a first hand experience.

5. Whenever it is possible to strike a balance between the amount of manuscript and the amount of illustration, it should be done. That is to say the space occupied by illustration on the printed page should usually not exceed the space occupied by the type. The exact ratio between the illustration and the type is not widely important but it is usually advisable to keep the printed matter somewhat in excess of the illustration.

The foregoing rules are, of course, only general but they are presented for the purpose of pointing out some of the difficulties, real or imaginary, which keep the average man from telling others what he is doing through the medium of technical or trade papers.

Imports of electrical goods, as determined by the Egyptian Customs Administration were valued at $2,676,-440 in 1921, having increased to this sum from a total of $1,114,461 in 1919. The amount received in 1920 was $2,204,652 worth, sowing a steady development. The Ministry of Communications of the Egyptian Government, which has control over the Railways, Telegraphs and Telephones and the Ports and Lighthouses Administrations, is the principal user of electrical equipment in Egypt, and is constantly in the market for electrical equipment. At this time the Ministry is particularly interested in automatic telephone exchanges.

Basic Principles for the Electrical Workman

A Series of Articles Explaining Clearly the Reasons Underlying the Operation of Simple Circuits and Apparatus

By K. C. Graham

Part 3—Electrical Calculations

THERE are three electrical words with which we must become intimately acquainted, namely, the *volt*, the *ampere* and the *ohm*.

The volt is the unit of electrical pressure.

The ampere is the unit of rate of current flow.

The ohm is the unit of resistance.

These definitions will be better understood by referring to Fig. 27.

Here a pressure of 10 pounds (corresponding to volts)

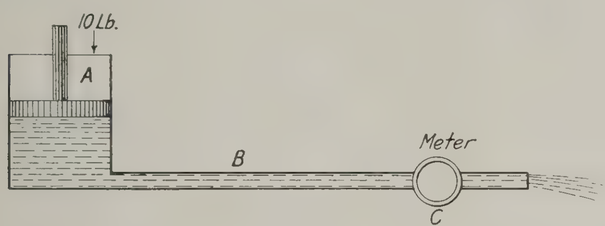


Fig. 27

forces water from container *A* against the resistance of pipe *B* (corresponding to ohms) and past meter *C* at a rate of a certain number of *gallons per second* (corresponding to amperes).

Now the relation between flow of current, resistance and voltage is such that volts equal amperes multiplied by ohms. This is known as Ohm's Law and if we know any two of the factors it enables us to determine the other one. Thus, to force 10 amperes through a resistance of 5 ohms, 50 volts pressure is required because volts equal amperes multiplied by ohms.

$$50 = 10 \times 5$$

Now, if we have a pressure of 50 volts and the resistance of the circuit is 5 ohms, the amount of current that

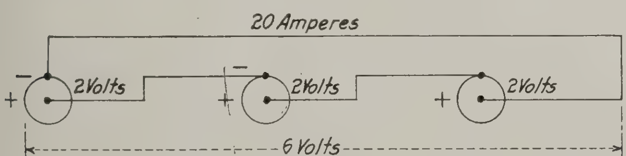


Fig. 28

will flow is equal to volts divided by ohms or 10 amperes.

$$50 \div 5 = 10$$

If the pressure is 50 volts and 10 amperes flow in the circuit, then the resistance is equal to volts divided by amperes or ohms.

$$50 \div 10 = 5$$

Thus it is seen that Ohm's Law exists in the three following forms:

Volts = amperes × ohms
Ohms = volts ÷ amperes
Amperes = volts ÷ ohms

Fig. 28 shows three batteries of two volts each, connected in series.

Fig. 29 shows three batteries of two volts each, connected in parallel.

Now, when batteries are connected in series their voltages add up to give a total voltage, which, in the case shown in Fig. 28, is 6 volts, but the current giving power of the combination is only equal to that of any one battery, that is, if the limit of current supply of any one battery is 20 amperes then the current giving capacity of combination of the three batteries, connected in series, is 20 amperes.

When the batteries are connected in parallel, as in Fig. 29, the voltage of the set remains at two volts while the current giving capacity is tripled and becomes 60 amperes.

It should be noted that the product of volts and amperes is the same in each case, for 6 volts multiplied by 20

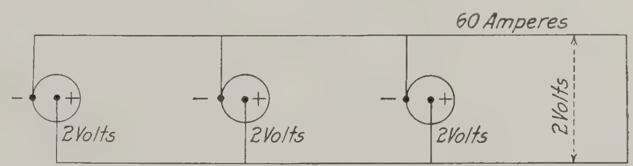


Fig. 29

amperes = 120 watts, and 2 volts multiplied by 60 amperes = 120 watts also. In other words the total amount of power in the circuit remains the same, only its form is changed. The product of volts and amperes is watts, the *watt* being the unit of electric power.

When an electric current flows it generates heat in the conductor, the ordinary incandescent lamp being an example of this principle. The amount of heat generated in any given piece of wire depends on the square of the current, that is, if the current is 2 amperes and it is increased to 4 amperes, the heating effect is four times as great when the current was 2 amperes because the heating effect varies according to the square of 4 (which is 16), which is four times the square of 2 (which is 4).

Now, the capacity of a wire to carry current is limited

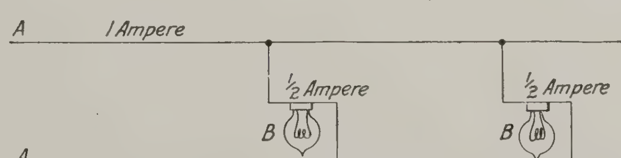


Fig. 30

to a certain definite amount. If the wire is insulated the insulation will be ruined if the heat becomes very great, and if the wire be uninsulated, it will melt or fuse after a certain degree of heat has been reached.

The amount of heat generated also depends on the resistance of the conductor. This may be better understood by referring to Fig. 30, Here we see that wires

A A carry 1 ampere and do not show any signs of heat while filaments *B B,* which carry only ½ ampere, are heated to incandescence, that is, the wires are cool because of their low resistance, while the filaments of the lamps are very hot because of their high resistance.

Referring to Fig. 31 *A* is a dynamo, generating current for the lamps *B B* at a pressure of 50 volts. The resistance of the lamps is 10 ohms, the resistance of wires *C C* is 0.1 ohm and the safe carrying capacity of wires *C C* is 10 amperes. The current flowing in the wires *C C* 50 volts ÷ 10 ohms = 5 amperes.

Now, suppose upper wire *C* breaks at *X,* Fig. 32, and makes contact with the lower wire at *Y,* then the only resistance in circuit is that of wires *C C*, which is 0.1 ohm, and therefore the current becomes 50 volts ÷ 0.1 = 500

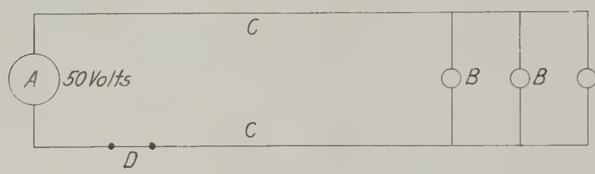


Fig. 31

amperes, which is enough to ruin the insulation of wire *C* and probably melt it. The dynamo *A* would also be damaged. This condition is termed *a short circuit.*

To prevent this a small piece of wire, called a *fuse,* is placed in the circuit as at *D,* Fig. 31 and Fig. 32. This fuse is a piece of wire whose resistance is much greater than that of wires *C C,* just as the resistance of the lamp filaments in Fig. 29 is greater than that of wire *A*. At a current of 5 amperes, fuse *D* is very hot while wires *C C* are comparatively cool. When a short circuit occurs, fuse *D,* which melts at 10 amperes, will melt before wires *C C* have become dangerously hot, thus opening the circuit and causing the current to cease flowing. When a fuse has melted it is said to be *blown.*

Fig. 33 shows a circuit containing a dynamo *A,* lamp *B* and resistance *C* and *D* connected in series by means of

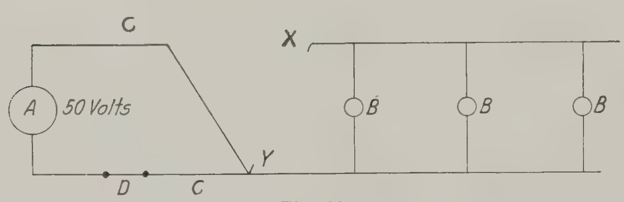


Fig. 32

wire *XX*. The voltage of the dynamo is 50 volts; the resistance of the lamp *B* is 2 ohms; that of unit *C* is 5 ohms, and that of *D* is 3 ohms. The resistance of wires *XX* is so small compared to that of the lamp and units that we shall neglect it in this case.

The total resistance of any number of resistances connected in series is equal to the sum of the resistances. For example, the resistance overcome in forcing current through all of the resistances, shown in Fig. 33, is equal to 2 ohms + 5 ohms + 3 ohms = 10 ohms. Now, it the voltage is 50 volts and the resistance is 10 ohms, from Ohm's law we find that the current is 50 volts ÷ 10 ohms = 5 amperes, that is, 5 amperes flow in the circuit.

When a resistance is overcome some pressure is lost, for instance, in forcing current through lamp *B* some of the 50 volts is used up, or in other words, the voltage remaining to force current through resistances *C* and *D* is less than 50 volts. This "using up" of the voltage (or voltage loss) is called *voltage drop.* A voltage drop always occurs when current flows.

The drop is found from Ohm's law which says that volts equal amperes multiplied by ohms. Thus the drop at *B* is 5 amperes × 2 ohms = 10 volts. the drop at *C* is 5 amperes × 5 ohms = 25 volts, and the drop at *D* is

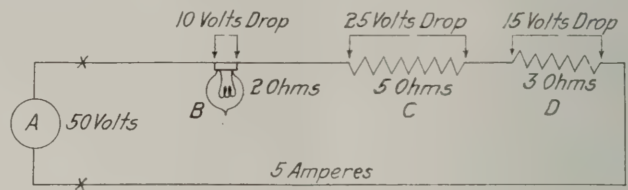


Fig. 33

5 amperes × 3 ohms = 15 volts. The total voltage drop is 50 volts or, in other words, the products of current and resistance are always such as to use up all the voltage applied to a circuit. Thus, if the voltage were 100 volts, as in Fig. 34, the current would have been 10 amperes and the drop across *B* would have been 20 volts, across *C,* 50 volts, across *D,* 30 volts and the total drop is seen to be equal to 100 volts.

When we connect resistances in parallel, the same amount of current does not flow through each resistance,

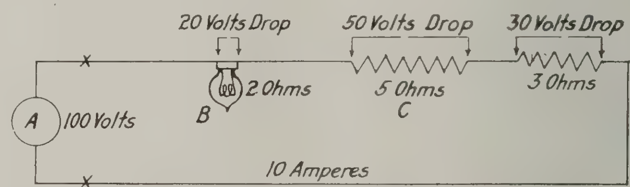


Fig. 34

as in the series connection, but is divided among the resistances in accordance with the resistance of each. To calculate the current flowing in each resistance, Fig. 35, we treat each one as a separate independent circuit. Therefore, according to Ohm's law we have 50 volts ÷ 2 ohms = 25 amperes in *B;* 50 volts ÷ 5 ohms = 10 amperes in *C;* 50 volts ÷ 3 ohms = 16.66 amperes in *D.* The total current flowing in *XX* is 51.66 amperes. The total resistance of the circuit is 50 volts ÷ 51.66 amperes = 0.9677 ohms. Here we see that the combined resistance of

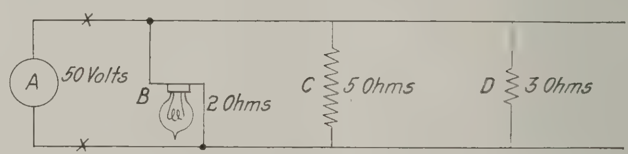


Fig. 35

all the resistances is less than the resistance of either *B,* *C* or *D.*

The resistance of a wire depends upon two things—its length and its cross-sectional area. The cross-sectional area is the area or size of the end of the wire. This is ordinarily called the "thickness" of the wire.

If a wire of a given cross-sectional area (say No. 10 wire) 1,000 feet long has a resistance of 1 ohm, then a piece of the same size wire 2,000 ft. long has twice the

resistance of the first wire, or 2 ohms. But if the length had remained the same as at first and the cross-sectional area had been doubled, the resistance would have been halved, that is the resistance of 1,000 ft. of wire twice as large as No. 10 would be only half as much as the resistance of the No. 10 wire, or ½ ohm. This shows that the resistance of a wire varies directly as its length and inversely as its cross-sectional area, that is, if the length

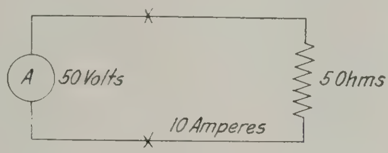


Fig. 36

is doubled the resistance is doubled, if the cross-section is doubled the resistance is halved. Also if the length is halved the resistance is halved, and if the cross-section is halved the resistance is doubled.

If we have a resistance of five ohms connected in circuit with a 50-volt dynamo, as in Fig. 36, the current flowing in wire XX = 50 volts ÷ 5 ohms = 10 amperes. If we connect another 5-ohm resistance in parallel with the first resistance (Fig. 37) the current in wires XX becomes 20 amperes, thus showing that the resistance of the circuit

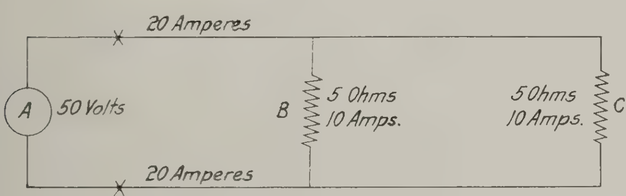


Fig. 37

has been halved. When a wire having a given resistance is connected in parallel with another wire of the same resistance it amounts to the same thing as if we doubled the cross-sectional area of the first wire. The point to be brought out here is that connecting a resistance in parallel with another is the same as adding to the cross-sectional area of the first resistance.

There is a law governing the calculations of resistance,

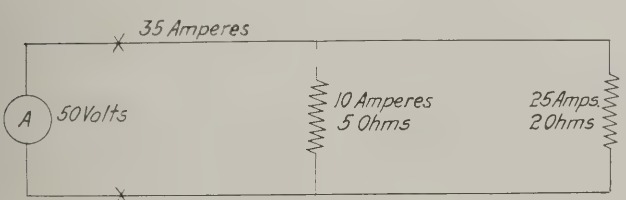


Fig. 38

connected in parallel, which may be stated in the following formula:

$$R = \frac{1}{1/R_1 + 1/R_2 + etc.}$$

Where R = combined resistance

R_1 = one of parallel resistances such as B (Fig. 37)

R_2 = another of parallel resistances as C (Fig. 37)

$1/R$ is called the reciprocal of R and is said to be the conductivity of R, for instance, the resistance of B, Fig. 37, is 5 ohms, therefore its conductivity or conductance, as it is called, is 1/5; that is, the conductance of B, Fig. 37, is 1/5. The conductivity of C, Fig. 37, is also 1/5, therefore, according to our formula.

$$R = \frac{1}{1/5 + 1/5} = \frac{1}{2/5} = \frac{5}{2} = 2\frac{1}{2} \text{ ohms,}$$

the combined resistance of B and C. The current flowing in the wires XX, Fig. 37, is 50 volts ÷ 2½ ohms = 20 amperes. As this agrees with our previous calculations of the current in XX, we know our formula is correct.

We shall now apply this formula to the problem shown in Fig. 38. The resistance of B is 5 ohms, therefore its

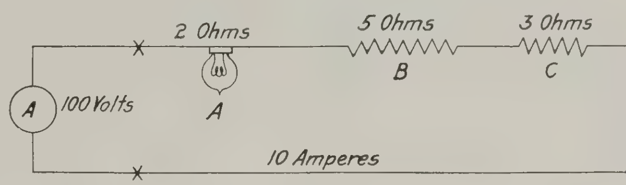


Fig. 39

conductance is 1/5. The resistance of C is 2 ohms, therefore its conductance is ½. Then

$$R = \frac{1}{1/5 + 1/2} = \frac{1}{2/10 + 5/10} = \frac{1}{7/10} = \frac{10}{7}$$

50 volts ÷ 10/7 ohms = 35 amperes flowing in XX.

Suppose we have resistances in series, Fig. 39, then the total resistance is 10 ohms, and at 100 volts the current is 10 amperes. Suppose, as in Fig. 40, we connect a 10-ohm resistance in parallel with the 5-ohm resistance then ac-

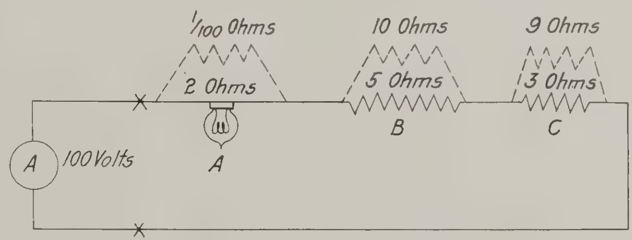


Fig. 40

cording to the law of parallel circuits, the combined resistance of the 5-ohm and 10-ohm resistances is

$$\frac{1}{1/10 + 1/5} = \frac{1}{1/10 + 2/10} = \frac{1}{3/10} = \frac{10}{3} = 3\frac{1}{3}$$

The resistance of the three sets of resistances is now 2 ohms + 3⅓ ohms × 3 ohms = 8⅓ ohms, and the current equals 100 volts ÷ 8⅓ ohms = 12 amperes flowing in the circuit.

Again, suppose we connect a resistance of 9 ohms in parallel with the 3-ohms resistance, then the combined resistance of the 3-ohm and 9-ohm resistances is

$$\frac{1}{1/3 + 1/9} = \frac{1}{3/9 + 1/9} = \frac{1}{4/9} \quad \frac{9}{4} = 2\frac{1}{4} \text{ ohms}$$

combined resistance. The current in the circuit is now

100 volts ÷ (2 ohms + 3⅓ ohms + 2¼ ohms) = 13 amperes.

Again, suppose we connect a resistance of 1/100-ohm in parallel with the 2-ohm resistance, then the combined resistance of the 1/100-ohm resistance, and the 2-ohm resistance equals

$$\frac{1}{1/2 + 1\text{-}1/100} = \frac{1}{1/2 + 100/1} = \frac{1}{201/2} = \frac{2}{201}\text{ohms}$$

or 1/100.5 ohm combined resistance. The current in the circuit is now 100 volts ÷ (1/100.5 ohm + 3⅓-ohms + 2¼ ohms) = 18 amperes.

Referring to Fig. 40, the drop across A (combination of 2-ohm and 1/100-ohm resistances) is 18 amperes × 1/100.5 ohm = 0.179 volt. Then the current in the 2-ohm portion is

$$\frac{0.170\text{ volt}}{2\text{ ohms}} = 0.089\text{ amperes and the current in the 1/100-}$$

$$\text{ohm part is } \frac{0.179\text{ volt}}{1/100\text{ ohm}} = 17.91\text{ amperes. Thus it is seen}$$

that practically no current flows through the 2-ohm portion and it is said to be *short circuited* by the 1/100-ohm portion.

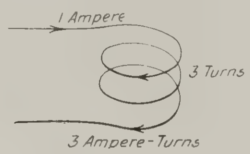


Fig. 41

Before proceeding to the study of generators we shall take up the two more important electrical terms—*ampere-turn* and *ground*.

The ampere-turn is important because the "pull" or strength of solenoids is measured by means of it. Fig. 41 shows a coil of three turns with a current of one ampere flowing through it. The magnetic strength of the coil equals amperes multiplied by turns which is equivalent to 1 ampere + 3 turns = 3 ampere-turns. If the coil had 10 turns and the current were ½ ampere, the magnetic strength would be ½ ampere × 10 turns = 5 ampere-turns. Thus we see that ampere-turns equal amperes multiplied by turns.

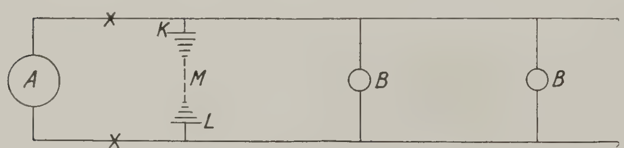


Fig. 42

Fig. 42 shows dynamo A supplying lamps B B with current by way of wires X X. Suppose the insulation were broken on upper wire X at K so that wire X touched the earth or some other conductor of electricity, then upper wire X is said to be *grounded* at K. This ground in itself would not cause any trouble but in case lower wire X becomes grounded at L, lamps B B will be short circuited, as shown by dotted line M, with consequent damage to wires X X and dynamo A, or in case the wires X X are fused, the fuse will blow.

Report of the Bureau of Locomotive Inspection

The eleventh annual report to the Interstate Commerce Commission of the chief inspector of the Bureau of Locomotive Inspection for the fiscal year ended June 30, 1922, shows an increasing number of locomotives inspected with a reduction in the number of defects and also a reduction in the number of accidents. A summary of the report follows:

A summary of all accidents and casualties during the year ended June 30, 1922, as compared with the year ended June 30, 1921, shows a decrease of 15.4 per cent in the number of accidents, a decrease of 48.4 per cent in the number killed, and a decrease of 11.3 per cent in the number injured.

During the fiscal year there were 33 boiler explosions, resulting in the death of 22 persons and the serious injury of 56 others, a substantial reduction as compared with the preceding year. Most of these explosions were caused by overheating of the crown sheet, due to low water. Proper inspection and repair of all parts and appurtenances of the locomotive, including the boiler, is essential to safe and efficient operation, especially the firebox, water feeding and indicating appliances, together with thorough boiler washing as often as water conditions require, and the removal of scale and sediment from the interior of the boiler which cause heating surfaces to overheat, crack and weaken, and frequently cause failure with serious results.

Investigation of accidents during the year, where the fusion or autogenous welding process was involved supports the position previously taken that the process has not yet reached a state of perfection where it can be safely depended upon in boiler construction and repair where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown-sheet seams where over-heating and failure are liable to occur, nor its excessive use in repairing long and numerous cracks in side sheets.

Records continue to show that approximately 80 per cent of all autogenously welded seams involved in so-called "crown-sheet failures" have failed, while 16.9 per cent of riveted seams have failed under like conditions. The fatalities where sheets tore have been seven and one-half times as great as where they did not tear. From July 1, 1916, to June 30, 1922, autogenously welded seams were involved in 22.1 per cent of the crown-sheet failures, while 44.1 per cent of the total killed in crown-sheet accidents were killed where the autogenously welded seams were involved.

A large number of accidents have been caused by defective grate-shaking apparatus, the majority due to the shaker bar not properly fitting the fulcrum lever. This condition has been brought about because of no standard design being maintained, making such parts interchangeable. It should be required, therefore, that all carriers adopt a standard whereby shakerbars can be made interchangeable on all of their locomotives with a proper fit.

"Loyalty makes the thing to which you are loyal, yours. Disloyalty removes it from you."

Swiss Diesel-Electric Motor Car with Trailer

Sulzer Diesel-Electric Rail Motor Car

Car With 200 hp. Diesel Engine Seats 69 Passengers and Shows Low Fuel Consumption on Swiss Railways

FOLLOWING the experiments with a direct-driven Diesel locomotive on the Prussian State Railways in 1913 orders were placed with Sulzer Brothers, Winterthur, Switzerland, for five self-propelled rail cars to be driven by Diesel engines coupled to electric generators with electric motors geared to the driving axles. Three of these cars were for use on the Prussian railways and two on the Saxon railways. Two of the cars were delivered and operated satisfactorily before the outbreak of the war, but since that time conditions have been such that no further development was undertaken until recently.

In taking up the work again the manufacturers, Sulzer Brothers, decided to take back the cars and equip them with engines of a new and improved type together with new electrical apparatus that had been perfected by Brown-Boveri of Baden. It is one of these rebuilt cars, now being tested out on the Swiss Federal Railways, that is shown in the illustration.

General Description of the Cars

The car is of standard gage and approximately 70 ft. long over buffers. There is an engine compartment at one end and operating platforms at both ends, the car being so equipped that it can be driven with equal convenience in either direction. Seats are provided for 69 third-class passengers with standing room for 16 more. Entrance and exit is made at either end through the roomy driving platforms which are separated from the body of the car by sliding doors.

The light weight of the car is 146,600 lb., 85,200 lb. being on the six-wheel truck on the engine end and 61,400 lb. on the four-wheel truck on the motor end. These weights correspond to an axle load of 28,400 lb. on the engine end and 30,700 lb. on the motor end.

The driving power is obtained from a six-cylinder, four-cycle Diesel engine of the Sulzer "R V" type which is connected to a direct-current generator through a flexible coupling. The fuel is injected directly into the cylinders through the injection valves without the employment of injection air, the necessary pressure being furnished by combustion of a part of the fuel itself. By the adoption of electric starting, obtained by a suitable winding of the generator and by the installation of storage batteries, air compressors with complicated valves and control mechanism which were used on the original installation have been dispensed with and the general design considerably simplified.

The three pairs of cylinders are arranged in a V form, each pair of pistons being connected to a common pin of the three-throw crank axle. The crank case is enclosed and provided with inspection covers while the cam shaft is parallel to the crank axle. The engine when running at 440 r.p.m. develops 200 hp. and is capable of delivering 250 hp. for a short time. It is designed to be run at a constant speed regardless of the speed of the car. The governor and feed pumps are placed in front of the engine, the control being such that each cylinder may be cut out automatically from the driving cab or controlled by the governor in the usual manner.

The exhaust muffler and the air inlet manifold are placed between the cylinders with the fuel tank above them. The capacity of the tank is 350 liters (92½ gal.) which is sufficient for a run of 50 km. (31.4 miles) under average conditions.

The cooling water after leaving the cylinders passes

to a series of ribbed coolers on the car roof. These are so grouped in combination with the water reservoir that by cutting units in or out the desired temperature can be maintained regardless of weather conditions and temperatures.

Vibration is avoided by mounting the engine and generator on a special frame which is not connected to the body of the car but is carried directly on the truck frame through spring connections. The weight of the front end of the car is carried by a spherical pivot which acts as a center pin and rests on a modified truck bolster.

The capacity of the engine is sufficient to drive the car at a speed of 70 km. or 44 m.p.h. on level track. When hauling a trailer weighing 66,000 lb. the available speed is 60 km. or 37 m.p.h.

Electrical Equipment and Control

The main generator is separately excited, the exciting current being furnished by a special dynamo mounted on an extension of the generator shaft. The main generator is of the eight-pole type and has a capacity of 140 kw. with a terminal voltage of 300 while the exciting dynamo is of the six-pole type with an output of 7.5 kw. The accumulator battery feeds the field windings of the exciter. The circuit between the generator and the motors is so arranged that the engine can be run at a constant speed regardless of the speed of the car. This insures easy starting, full control of the speed of the car and economy in fuel consumption.

Two direct-current motors are mounted on the four-wheel truck on the rear end of the car. They are fitted in a common cast steel casing and both are geared to a crank shaft which carries crank discs, connecting rods being employed to transmit the power from the crank discs to the driving wheels. The motors are series wound with six main poles and six inter-poles. The engine is started by using the generator as a motor operated by current from the storage battery underneath the car. Direction switches and controllers are provided on either platform. The controller handle is of the dead-man type and if not held down the current is shut off and the brakes applied. A time relay with a retarding cylinder holds back the application of the brakes until five seconds have elapsed from the time the current is cut off.

The brakes are of the Westinghouse type, the compressed air being supplied by a small air compressor driven by the engine. In emergency applications, the current is automatically cut off. Hand brakes are also provided.

Operating Results

On a somewhat hilly road between Wallisellen, Winterthur and Romanshorn with the car alone without a trailer, the fuel consumption was 84 kilos or 185 lbs. for the round trip of 92 miles, which is equivalent to 0.03 lb. of fuel per ton-mile. The load was subject to frequent variations and the engine was shut down on the lower grades, being in operation only about two-thirds of the time.

Records covering a month's service on the Baden, Wettingen and Niederglatt run showed an average fuel consumption of 0.043 lb. per ton-mile. The consumption was at the rate of 0.047 lb. per ton-mile at first but fell to 0.040 lb., probably due to the longer experience and increased skill of the driver. In these records the fuel used for switching, recharging storage batteries, etc., was included while the mileage was taken as that in regular service.

This car has attracted considerable attention in Switzerland and as a result a second car will shortly be placed in service on the Berne-Neuchatel section of the Lotschberg railway. Not only has the fuel consumption been remarkably low but the small stand-by losses and the short time required for attention at terminals have shown that a car of this type possesses decided advantages over steam operation. Fifteen minutes is sufficient to start the engine, charge the air brake system and have the car ready to start. Even less time is required to shut down and leave everything in order.

The car is of moderate power but its range is considerable and its size is much larger than most of the gasoline rail motor cars used in the United States. It is hoped that further experience will lead to the construction of large units which will result in a Diesel locomotive.

Advantages of Diesel Electric Locomotives*

By L. G. Coleman
Assistant General Manager, Boston & Maine

There has been great development of the Diesel engine in the past five years, but only the surface has been scratched. Such engines have been projected for stationary service that will weigh in the vicinity of ninety pounds per horsepower, in which design the question of weight has not been a primary factor. Competent Diesel engine designers say that there is no reason why such engines may not be built at least as light as sixty pounds per horsepower.

A modern Santa Fe type locomotive with fully loaded tender weighs approximately 283 tons. An electric locomotive of similar tractive effort can be built at about 130 tons, and will require available at its maximum point of consumption 1,800 kilowatts. Under accepted practice this power is generated in a central stationary power plant and distributed by means of a trolley or third rail. If we can produce the current required for each electric locomotive in a movable power plant which may be attached to that locomotive, we can obtain the advantages of the electric locomotive and dispense with the disadvantages of the steam boiler.

To produce 1,800 kilowatts requires a brake horsepower of about 2,600. At 60 pounds per horsepower, this would require one or more Diesel engines of an aggregate weight of 78 tons, one or more generators not over 12 tons, a chassis to carry this load, say 40 tons, leaving 20 tons for radiation and auxiliaries. To recapitulate, for 280 tons, the same approximate weight as a Santa Fe, we may assemble a flexible, movable, fully self-contained power plant and locomotive, driven by Diesel engines using low-grade fuel, that will be at least as economical as coal, with none of the disadvantages of the steam boiler.

Design Provides Great Flexibility

The possibilities in design are so varied as to offer many opportunities for economies. Great flexibility is possible. The locomotive can be in one unit; the power

*Abstract of a paper presented before the New England Railway Club, Boston, January 9, 1923.

plant another. The power plant itself can be subdivided. For example, the unit I have proposed would probably be made up of three or four Diesel engine generator sets mounted on a single chassis. This assembly could be so arranged that in case of failure of one of the power sets it could be replaced quickly by a spare unit and the whole restored to service in a few hours. By building the motor and power units separately they could be interchanged in case of heavy repairs being required by either.

In case of failure of one generator set the remaining ones would still be able to handle a considerable train instead of causing the complete failure that would follow a similar occurrence with one large power unit.

The electrical combinations as to voltage and amperage are increased by the possibility of hooking the units up in series of parallel. The machinery of the power plant can be under constant observation as in any stationary plant, and when one unit is cut out by reason of reduced power demand, it can receive minor adjustments without delay to the train. When such a locomotive is designed, it will be possible to run it much longer mileage between repair points than the most efficient steam engine.

I have in this brief discussion used the Diesel engine as the foundation of the scheme, because up to date it has been the most economical power producer available for the use I propose.

Other Types of Engines May Be Suitable

I am not at all sure, however, after full investigation and study, that the gas engine as used in automobiles and airplanes may not work out more successfully than the Diesel engine. The main obstacle to its use at the present time is the cost of fuel for such an assembly. It does not necessarily follow even at the present wholesale price of such fuels that the decreased weight, and first cost, and the greater flexibility gained, will not very nearly counterbalance the fuel saving of the heavier Diesel type.

There is another, to me, very interesting possibility which such a development would bring forth, namely, the use of fuel alcohol. If an engine should be developed using alcohol and there was any prospect of its being used in quantities, the next step, namely, a cheap supply, is a comparatively simple matter and need not be a stumbling block.

There is a third possibility, namely, the use of the Diesel engine direct, without any other than mechanical means of transmission of power. It, as you all know, has received some attention in Europe. This does not appear to me to hold forth the same promise as the use of electric transmission with its very much greater flexibility.

Research Needed to Reduce Cost of Operation and Maintenance

I have for obvious reasons only outlined this scheme in its broadest aspects. I have used only approximate weights and general description, but they are all within limits of known practice. To bring it to a successful issue will require the most painstaking work of experts in Diesel-engine and electric design, as well as a great many experiments.

The cost of locomotive operation and maintenance is so great today, and so much greater than in the past, that it is the most serious problem facing all railroad officers and needs heroic treatment.

Twelve Years' Experience With Alternating Current Traction

Twelve years' operation of electric traction on the London, Brighton and South Coast Railway is the title of a paper submitted to the Institution of Civil Engineers in England on January 9, 1923, by Henry Walter Huntingford Richards. A number of facts are stated which will unquestionably be of interest to anyone concerned with either alternating or direct current equipment. The following is an abstract which was taken from the paper:

Rapid development of electric traction has been prevented by the European war, and, since its termination, by various other factors. This period of comparative inaction, however, has, perhaps, permitted experience in practical operation to be gained, sometimes with unexpectedly heavy traffic under conditions of reduced facilities. Important sections of the suburban lines of the London, Brighton & South Coast have now been operated electrically on the single-phase system, at 6,700 volts, for about 12 years. The author puts forward the following as main principles on which operation should be based: (1) Maximum reliability of equipment compatible with reasonable financial considerations; (2) Arrangement of renovation and general work so as to prevent undue fluctuation of costs; (3) Continual effort to improve the life or working of the equipment. And the following as measures calculated to assist in the application of these principles: (1) A group method of organization for correctly allocating the costs of labor and material against the section concerned; (2) a clear division of all work under the two main headings of "Running-Maintenance" and "Repairs"; (3) preparation of graphic records and statistics of all results of practical operation and their circulation among the staff concerned.

Rolling Stock—Electrical Equipment

The efficiency of the current-collector gear is of fundamental importance, a difficult matter when the contact-wire varies in height from 13 ft. 9 in. to 20 ft. and has occasional steep gradients. The original bow-gear is running today, with only slight modifications, on every motor-coach. At coach overhauls the operating-springs are set to standard lengths so as to maintain a pressure of 12 lb. on the bow-strip at a trolley-wire height of 16 ft.

As usual for motor-coach equipments, the control is of the multiple-unit type. There are three principal train-circuits, namely, high tension main circuit at 6,700 volts, low tension power circuit at 450-750 volts, and low tension control circuit at 300 volts. It is found that a new motorman can obtain a working knowledge of the control system in from two to three weeks. The presence of the high tension chamber in the guards' compartment has caused no trouble.

The motors in use today are of the Winter-Eichberg single-phase compensated repulsion type, designed about 15 years ago. Most of the motor troubles have been due to weakness in the mechanical design, and improvements have resulted in train defects being reduced by about 75 per cent. Split gears have been used hitherto with varying results, but gear-wheel and pinion lives of 250,000 miles have frequently been obtained. Solid gear-wheels

of present-day manufacture should enable lives up to, or perhaps exceeding, 500,000 miles to be expected.

The transformers have so far been very satisfactory and reliable, only five defects having occurred among seventy-one transformers of the 310-kva. type, many of which have now reached 500,000 miles. After about 10 years' service the sheet insulation between the high tension and the low tension coils was renewed, and it is hoped that a considerable further life will accrue before further attention is required.

Rolling Stock—Mechanical Equipment

In motor-coach trucks every effort should be made to keep all clearances down to the minimum practical limit of wear. For this purpose axle-box horn-checks have been fitted with U-shaped gun-metal liners, and similar attention has been given to all other points of wear, on bolsters, transoms, etc.

Good braking is of the utmost importance. The Westinghouse automatic air brake, combined with clasp brakes and an automatic slack-adjuster, enable an average deceleration of not less than three feet per second to be maintained, and the brakes to be released within about three seconds. Drivers' brake-valves are cleaned and greased in position once in three months, and triple valves once in six months.

The original decision to use "side-door compartment stock" has been completely justified by the operating results obtained. Trains can be emptied and filled at terminal stations in about the same time as the motor-man takes to walk from one end to the other. All the original slam locks of the safety-catch type, with internal operation, are still in use.

The voltage provided for train-lighting is 300 volts, and four lamps are placed in series on each circuit. There are four 21-watt lamps in each compartment, but on different circuits.

Repair Shops

Repair-shop and car-shed facilities are limited, and it is important, therefore, that both general overhaul and inspection work should be kept strictly within the mileage limits fixed for each job. Further, detail inspection is done by day, once in three weeks, and night work is confined to indispensable electrical and mechanical examination. General overhaul of motor-coaches takes place at 60,000 miles, equivalent to 18 months' running, and of trailer-coaches at 120,000 miles.

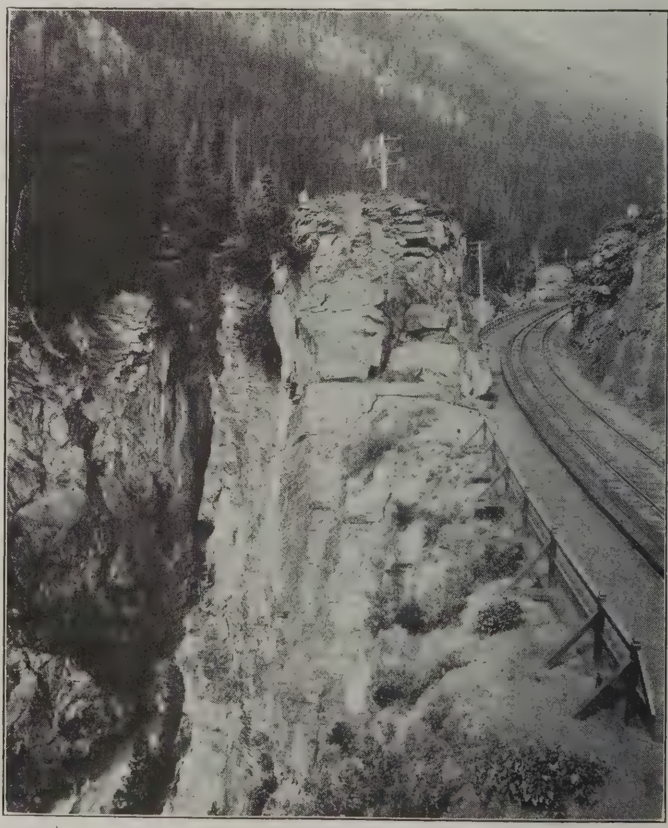
Electric Track Equipment

In order that the current-collection by the bows may be good, considerable attention has been given to rendering the trolley-wire absolutely flexible at all points. It is also desirable to provide the overhead construction with such uniform strength and resistance to deterioration that inspection and minor repairs can be safely eliminated, and that renovation can be carried out in a wholesale and convenient manner, like the renewal of track, thus effecting the greatest economy. On sections where there is no steam traffic the renewal of catenary and dropper wires necessitated by corrosion is only about 10 per cent of that on sections where a heavy steam traffic is still running. The rate of wear of the trolley-wire has been found to be almost directly proportional at any point to the amount of current collected there.

Two central distributing switch-cabins, with one attendant in each, together control the supply and distribution of energy to the whole 70 miles of electrified line. When necessary, the trolley-switches in local switch-cabins are operated by the staff at the station concerned in accordance with telephoned instructions from one of the central switch-cabins. As the whole line is divided into five group-sections, for which group-switches with instantaneous tripping are provided in the central switch-cabins, switch-gear operation and maintenance is chiefly confined to these group-switches. An advantage of high tension distribution is that the difference between fault and normal currents is very marked, and the consequent automatic location of faults materially conduces to safety and reliability of operation.

Train Handling

The characteristic of the motors is such that the use of only five controller-steps increases the voltage in such a way as to obtain almost uniform acceleration until a comparatively high speed is reached. Motor-men advance the controller according to the value of the current indicated by an ammeter, and the points for shutting off current are marked by "coasting-boards" fixed at the side of the line. During 1921 the average energy-consumption was 75.8 watt hours per ton-mile, the train service being 5,959,737 coach-miles, with a distance between train-stops of 1.14 mile, an average running-speed of 24.36 miles per hour, and a schedule speed of 22.11 miles per hour, including stops. A series of test runs was recently taken over a range of 0.4 mile to 9 miles between stops, from which it appeared that for the latter distance an average running-speed of 33.1 miles per hour could be obtained with an energy-consumption of only 40 watt hours per ton-mile.



Albert Canyon, Canadian Rockies

Scrapping Steel Cars by Means of the Carbon Arc

Electric Cutting Process Proves an Economical Method for Reducing Scrap to Sizes That Can Be Cut in Shears

By E. H. Dralle
Westinghouse Electric & Manufacturing Company

THE electric arc has for some time been recognized as a most potent agent for the fabrication and production of mild steel structures, and as perhaps the most economical means obtainable for the repair of worn or broken steel members, especially where they are of appreciable thickness or volume; but as a means for reducing scrap material to convenient sizes for remelting, the value of the carbon arc has been only recently appreciated.

Perhaps the railroads, always among the first to exploit new welding developments and to experiment with new suggestions involving electric arc processes, stand to profit most by the widespread use of the electric arc as a means for scrapping steel coal and coke cars. In the past, it was a common practice among many railroads to turn worn-out cars over to wrecking companies for dismantling, but the possibility of using the carbon arc advantageously for this service is resulting in the discontinuance of this practice and the adoption of a plan whereby all wrecking of cars will be done within the railroad shops. This condition will, without a doubt, result in a saving of time and expense.

Operator Cutting Through the Sides of a Car; the Cut Will Be Continued Straight Across the Bottom and Up the Opposite Side to Remove the End of the Car

Various Methods of Dismantling

Assuming that the car wrecking is done within the railroad shops, the problem demands considerable study to determine the best method of dismantling; that is, there must be a choice among:

(1) Cutting the heads off the rivets, and dismantling in the reverse order of assembling.

(2) Reducing the cars to suitable scrap sizes, entirely by cutting with the carbon arc.

(3) Reducing to sizes suitable for handling by four men, and finishing the scrapping by means of a large shear or shears, whichever is required to meet conditions.

These methods will be considered in order without regard to any peculiar local conditions existing to influence the adoption of any particular method.

Selecting the Most Economical Method

It is probable that scrapping by cutting the heads off the rivets would be found desirable where parts of the car could be salvaged for use in the repair of other cars. In fact, it is in this service where rivet cutting is most widely applied. It is doubtful, however, if this would prove a profitable scheme of scrapping cars, even though employed to a great extent by wrecking companies.

To work entirely satisfactorily, all rivets that are to be cut should be in a plane closely approaching the vertical, so as to allow the molten metal a ready means of escape. Attempting to cut the heads off rivets in a horizontal plane will result in actually welding the plates to the rivets unless means are employed to force the metal from its position as rapidly as it is melted, as for example by using a strong current of compressed air. Such a procedure would be cumbersome in manipulation, and for this reason, objectionable. However, in vertical planes this method of dismantling would compare favorably with straight cutting.

Time Required for Cutting Rivets

On an average coal car, there are approximately 1,400 rivets above the main frame of the car. With ⅞ in. diameter rivets, and a current value of 800 amperes, it has been demonstrated that an average of 8 seconds' actual cutting time is required per rivet. Obviously, then, the cutting time for a complete car would be 1,400 times 8, or slightly more than three hours. The discomfort caused by the use of these heavy current values makes it impossible for an operator to work continuously. This fact, coupled with the time consumed in moving from place to place will result in a working factor of perhaps 80 per cent, so that the cutting time is raised to $3 \div 0.80$, or 3¾ hours.

After the cutting is completed, one man with an air hammer; or two men, one with punch and the other with a heavy hammer, must force out the stub ends of the rivets to complete the dismantling. This operation would require the greater portion of 1¼ hours, so that the time to dismantle a car down to the main framework is practically five hours.

The cost of scrapping a car by this method would be divided as follows:

Labor at 60 cents per hour—6¼ hours (5 hours for arc operator and 1¼ hours for helper to remove rivets)	$3.75
Power at 2 cents per kw. hr. (3 hours using 48 kw.-800 amp., 60 volts, from general efficiency of machine, 70 per cent)	4.20
Total cost, not including maintenance, interest on capital invested and depreciation of machine	$7.95

Adding to the above figure the cost for reducing the

main framework of the car, would give a direct cost of about $15 for scrapping one car. The operating rates are not sufficiently fast to permit of one cutter scrapping two cars per day. To be practical, this schedule of two cars per day per cutter should be obtainable.

As pointed out, the above method is applicable where it is desired to salvage parts for rebuilding into other cars. Where cars are in such bad condition as not to warrant the saving of parts, best results are obtainable by using the straight cutting method to reduce to sizes suitable for handling by four men, especially since the cost of dismantling will be less than $10 per car as compared to $15 for the rivet cutting method.

To arrive at a figure upon which to base a cost for scrapping cars, a test, as will later be described, was conducted, and an accurate record kept of all results. The car was a standard coke car, having solid metal bottom, ends and half sides, the upper halves of the sides being of expanded metal.

Scrapping by Cutting Through Sheets and Frame

Starting at one of the four upper corners, immediately below the top supporting angle—this being left intact to make sure that the side would not fall out until the desired time—the cut was made down the corner to the floor of the car, thence along the entire length of the side, directly above the floor, and up to the other corner. The top angle-iron supports were then cut at the corners, and the side allowed to drop down. The time consumed was 51 minutes, and the distance cut was 43½ ft. The original thickness of material was ¼ in. sheet, but paint and rust in some places made the equivalent thickness in terms of clean iron sheets greater than ¼ in. On the other hand, corrosion was so effective as to reduce the equivalent thickness below ¼ in. in many places. One-fourth inch, however, can be taken as an average value for the thickness of material cut. It should be remembered that on account of the paint and scale on this iron, cutting conditions are entirely different from those experienced with cutting clean iron sheets.

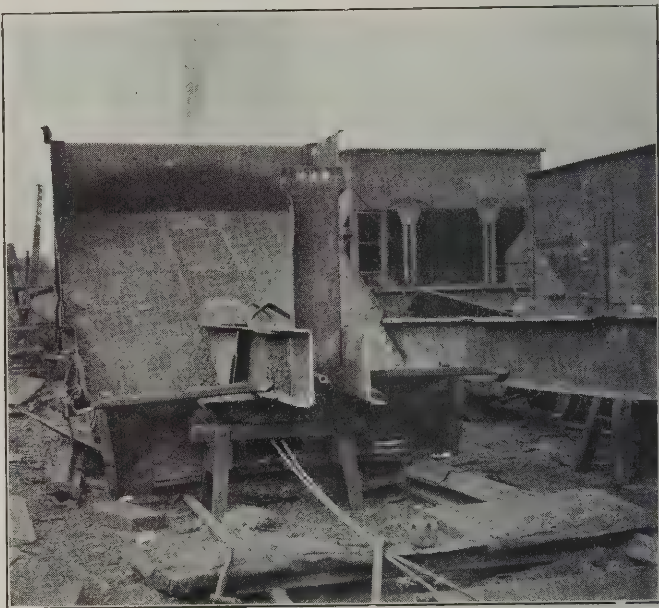
As soon as the car side was dropped to the ground, it was cut up into three equal pieces by making two cuts along lines parallel to, and equidistant from the ends. Each cut was through 2½ ft. of ¼ in. solid material, requiring twi minutes' cutting time, and 3ft. of expanded metal requiring 30 seconds' cutting time.

A similar procedure was used on the second side of the car, which was cut into the same number of pieces as the first side.

At each end of the car the car bottom sloped at an angle of approximately 45 deg. from the frame to within 3 ft. of the top of the car. The length of this sloping sheet is approximately 6½ ft. After cutting out both sides of the car, cuts were made across the car along the line described by the intersection of the sloping bottom sheets and the bottom of the car. This cutting, too, was through material ¼ in. in thickness. The length of cut was 9 ft. on each end, and the time of cutting seven minutes.

After cutting the ends as above described, it remained to cut four upright, 3 in. by 3 in. angles, and one 2 in. by 2 in. angle, all ¼ in. thick, directly above the car frame, to allow the ends to fall to the ground. The time required for this operation was seven minutes on one end, and four miutes on the other, the difference in the two times being due to the brake mechanism which had to be cut on the end requiring the greater time.

With the operations thus far, the car had been cut into eight pieces, three pieces on each side, and each end constituting one piece. To further facilitate handling, a cut was made the entire length of the car, parallel and adjacent to the center sill, and then two cuts were made across the bottom, directly back of each bolster. The lengthwise cut, 20 ft. long, required 40 minutes, and the cross cuts, each in effect being equivalent to 12 ft. of cutting, required 20 minutes each, or a total of 40 minutes. The greater portion of this time in making the crosswise cuts on the bottom was consumed in making the cuts



Center Sill Cut Through After Side Sheets and Side Frames Have Been Removed

through the center sill. The vertical members of the center sill together with the side frames, which approximated almost one foot in depth, account for the 12 ft. of cutting across the bottom of the car, which is only 9 ft. wide. Moreover, in making the lengthwise cut, it was also necessary to cut through two heavy channel door supports.

With the operations as described for cutting up the main frame and bottom of the car, it will be seen that the total number of pieces into which the car was cut was 14. Of course the whole truck on each end remained intact, but the cutting was done in such a way that the framework could be entirely removed from the trucks.

The object in cutting the material to sizes suitable for handling by four men, is in keeping with the scheme to have a large shear or shears to which these larger parts will be carried by the men for cutting up into pieces suitable for remelting.

It is possible for four men to handle the side and end pieces as cut, but on account of the heavy framework and material in the bottom of the cars, additional cuts are necessitated to facilitate handling. It will be found advantageous and economical to reduce these heavy parts to suitable sizes for remelting, without transporting them to the shears. The cutting could be done completely by the carbon arc.

To more clearly show the cuts which were made on the

car, the number of feet for each cut, and the total time for cutting, Table I has been prepared.

TABLE I—DETAILS OF CUTTING WITH CARBON ARC IN SCRAPPING STEEL CAR BODY

Location cut	Material cut	Length of cut feet	Number of cuts	Time per cut min.	Total feet cut	Total time, min.
Lengthwise—side	¼ in. sheet	43.5	2	51	87	102
Crosswise cuts on side sheets	¼ in. sheet	2.5	4	2	10	8
	exp. metal	3	4	½	12	2
Ends at intersection of bottom and sloping bottom sheets	¼ in. sheet	9	2	7	18	14
*Upright angles on each end	5—3 in. by 3 in. by ¼ in. angle.	½	11	1	6	11
Cross cuts on bottom	¼ in. sheet and channels	12	2	20	24	40
Lengthwise cut at bottom	¼ in. sheets and angles	20	1	40	20	40
Total					177	217

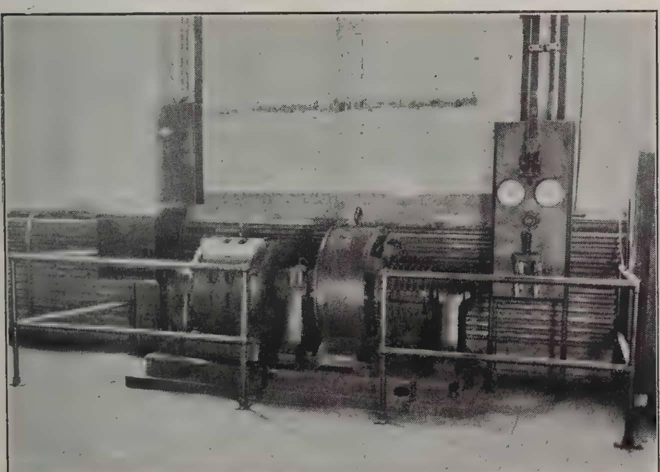
*For purposes of calculation, the angles on each end were taken as 3 in. by 3 in., and five counted on each end. One end had the brake mechanism mounted on it, which required practically three minutes' time to cut making seven minutes' cutting time on one end, and four minutes on the other.

From the above table, the following costs were obtained:

Total number of feet cut (equivalent of ¼ in. sheet)	177 ft.
Actual cutting time in hours	3.61
kw. hours consumed (850 amp., 60 V., M. G. set eff. 80 per cent 64 kw. for 3.6 hours)	230
Cost of labor at 60 cents per hour	$2.16
*Cost of power—2 cents per kw. hour	4.60
Total	$6.76

*Two cents per kw. hour for power is only a basic figure. This should be much smaller if power is bought in large quantities, or if the customer generates his own power.

Assuming that the operator's time is eight hours per car instead of less than four, as shown for the actual cutting time, the cost per car will still be less than $10, because only the item of the operator's time changes, the actual cutting time being the same whether the operator



Motor-Generator Set of 1,000 Amperes Capacity Used for Arc Welding and Cutting

spends a full day on the car or a half day. To be perfectly exact, the power bill will slightly increase, because the losses of the set go on as long as the set is running.

To have one man (cutter) completely wreck a car for cutting into sizes suitable for remelting, would result in greater expense, since a shear can reduce the smaller pieces at a more rapid rate than can be done with the arc, and the four men employed to carry material to and from the shears could be utilized by several cutters. Some few men would necessarily be employed for loading the scrap, and a few additional could be used to advantage to assist in carrying material to and from the shears.

The cost of shears, interest on investment, and depreciation of the machinery must also be considered in this connection, but unquestionably these items can be more than favorably balanced against the extra cost of operators and machines to supply them in order to do equal amounts of work per day.

Any one of the proposed methods of scrapping cars with the carbon arc will result in a great saving over the cost to do the same work with the acetylene torch. Paint, scale, and oxides which give way rapidly under the intense heat of an electric arc, are obstacles of no small importance when cutting with the acetylene. Furthermore, the cost of gas is one of the greatest items of expense, inasmuch as the torch is usually allowed to burn regardless of whether cutting is being done or not. With the electric arc, power consumption ceases when the operator fails to maintain an arc.

Aside from the cost of doing the work with gas, the inconvenience of hauling tanks, both empty and filled, to and from supply points, makes the electric arc (where power is always at the operator's command) stand out by far the more favorable of the two processes.

Equipment Required for Electric Cutting

The electric equipment for supplying power to the carbon arc consists simply of a motor-generator set and the necessary motor-generator control and cutting panel. A desirable form of machine is shown in the illustration. The set comprises a suitable motor, either a. c. or d. c., driving a low voltage compound wound d. c. generator. The generator is controlled entirely by a panel mounting a circuit breaker, ammeter, volt meter, and knife switch, as shown.

In addition to the above equipment, there are required only a suitable mask, electrodes and holders, and a cutting resistor for each operator.

The cutting resistance is comprised of four frames of resistance mounted in an angle iron framework, having overall dimensions approximately 48 in. long, 35 in. wide, and 17 in. high. This complete unit is mounted on a trolley which allows the resistor to be moved along the car as cutting progresses. This feature eliminates a long electrode holder cable. The entire carriage can be easily moved along the trolley track by simply pulling on the properly secured electrode holder cable. On the front of the resistor unit is mounted a slate, 15 in. by 13 in. by 1 in. thick, having mounted on it two 200-ampere, single-pole, single-throw knife switches. These knife switches control resistance steps of such value that current values of 400, 600 and 800 amperes may be obtained for cutting service. The 400 ampere resistance step is permanently in the circuit, and each of the knife switches controls one 200-ampere step.

Plant layout is an important feature in the successful use of the arc process for scrapping steel cars, and while local conditions will largely determine the nature of each installation, experience has shown that best results are obtainable with a layout such as described in the following paragraphs.

It is preferable to have a separate building for this cutting service. The building should be divided into booths, accommodating one car each, and should be so designed that the motor-generator set, or sets, supplying power will be centrally located with respect to the arc cutters, power for which will be conducted along an overhead trolley. On this trolley, mounted on a carriage as de-

scribed above, is the cutting control resistor with cable and electrode holder attached. The power for all operators is conducted through the trolley circuit, but each operator has his own cutting resistance, and can use any current value suitable for the work which he is doing. This arrangement of the power circuit positively insures non-interference among operators, regardless of how many are operating from the circuit. By having the resistance on a movable trolley directly above the operator, maximum cutting rates are obtained, since the movement of cables and holders to the most inaccessible positions on the car, is accomplished with minimum time and effort.

The object in having separate booths for each car is to protect operators from injurious reflected rays, and often, perhaps, direct rays from adjacent arcs. As a safety precaution, it is desirable to have only one operator per car, although with a properly outlined system of dismantling, it would be entirely possible to use two operators per car.

While the work done thus far on dismantling cars by the carbon arc process has shown that this method is decidedly superior to other methods of scrapping, it is entirely possible that a more widespread use of this process will result in new and improved means for wrecking cars, which will still further decrease the already low cost of dismantling by the arc process.

Effect of Impurities In Storage Batteries

An investigation has been undertaken by the Bureau of Standards to establish, if possible, a speedy and accurate method for the measurement of the effect of impurities in storage battery electrolytes. Methods which have previously been used require considerable time, and accurate and consistent results are difficult to obtain with them. The new method which has been devised is based upon successive weighings of the positive or negative plates while immersed in the solutions to be tested, which are maintained at a constant temperature. The battery plates were immersed in the various electrolytes contained within a thermostat bath and so arranged that any plate could be brought in the arm of a sensitive balance for weighing. Weighings of the plates were made daily, and the results were computed as the increase in weight of the plate per hour. The results showed considerable differences in the rates of sulphation of plates made by various manufacturers, and marked differences in the rate of sulphation produced by different concentrations of the acid solution were demonstrated. Temperature also plays an important part in determining the rate of sulphation.

The electrification bureau of the Austrian federal railways has just jublished a statement to the effect that further progress in the electrification of the Aurtrian Alpine railways is jeopardized because of lack of funds, according to a report to the Department of Commerce from Consul R. W. Heingartner, Vienna. Water power construction work is far advanced in the Arlberg district, but expenses have risen so greatly that construction work has had to be reduced and laborers dismissed because the government is unable to advance the necessary funds.

It was planned to complete the electrification of the Federal Alpine railways by the end of 1926. The total cost yet to be covered being 177,000,000 gold crowns (about $35,400,000). What is needed, says Consul Heingartner, is foreign capital to subscribe to an electrification loan in order that the development of hydro-electric power may not be subject to further obstacles.

P. & A. Photo

A Modernized Railway Dock at Tampico, Mexico

Pantagraph Extension

We are indebted to the Swedish State Railways for the accompanying illustration which shows a four-wheel standard gage push car or trailer carrying a framework on which a specially designed current collector is mounted on four insulators. The device is designed particularly to facilitate moving electric locomotives into enginehouses.

Where a high voltage overhead trolley is used, it is usually impracticable to continue this wire into the enginehouse. A high voltage wire is not wanted where work is being done, there is usually insufficient overhead clearance and the need for closing enginehouse doors introduces complications. Accordingly, an insulator is placed in the current carrying wires just outside the enginehouse doors and they are dead-ended on the house.

Electric Locomotive with Trailer Carrying Pantagraph Extension

In this country, it is common practice to use one locomotive outside the house to push another, with pantagraphs or collectors lowered, inside. The device shown makes it possible for a locomotive to move independently. The small car is coupled to the locomotive and the straight extensions of the conductors on top of the car, shown at the left in the illustration, come in contact with the lowered pantagraph and the extended bow collector at the right makes it possible for the locomotive to enter the enginehouse without losing contact with the overhead wire. The car may then be pushed away by hand, thus allowing the doors of the enginehouse to be closed.

The Wireless Bug

The "wireless *bug*" began to chew; to nibble on our office crew; then they began to rave, of circuits shown in high brow books, which stated how to bait the hooks, to catch the little *wave*.

They next dug down into their jeans and sprung themselves beyond their means, to appease this new desire; they fell for all the salesman's bunk and carted in a ton of junk; much crystals, coils and wire. These they fastened to a board and with a head set on their gourd, they hunted for a "spot," which in the parlance of the day, when *radio* is on the way, gets doggone good and *hot*. But tiring of this local stuff (it may be good but not enough) they yearned to span the earth: they figured out where they could spend, a thousand bucks and in the end, they'd get their money's worth.

New doodads came upon the scene, in colors brown or tan or green (it all was Greek to me) charging sets and deformed tubes, were purchased by these busy boobs, in wild and frenzied glee. There were rheostats and grids and shunts; dials to use in nightly hunts, for stations far away. There were slantwise coils and rubber knobs and Bakelite in sheets and gobs, piled up in wild array.

These were assembled by the bunch, while each one nursed a little hunch, that his particular set would reach 'way out among the stars and grab off jazz direct from Mars. They loved their little pet.

One night I was invited out, to hear a glad world yelp and shout—to soak up news and song: my friend put on a ghoulish grin, while vainly trying to tune in, he *sez* "it won't take long." He tweaked a dinkuss, pulled a plug: quick, *something* answered back "glug-glug": he turned his rheostat; he shoved a hickory to the right, which picked for him a tom-cat fight, with hisses sharp and flat. About the time he got Q. P., a band cut loose at X. Y. Z., with noises shrill and rare; while tuning in for H. P. A., a swarthy preacher in Bombay, began to use the air. Then gently he adjusted down, to pick up "Op'ra" here in town, 'twas Madame Butterfly, but Great Lakes then began to shoot a lot of code 'way out to Butte and stalled a song on high. We plucked a lot of *z-z-z-zs* then some squawky cackles from a hen; we heard a Chinese play; we thought we sensed a grunting pig, ten explosions that were big and an earthquake on the way.

Patience is a virtue rare, but needed when one combs the air, from dusk to late at night. My system now is filled so full, of forty meter wave length bull, I *dare* the "bug" to bite.

He Who Shirks

He cannot hope to reach the crest
Who loiters on the way;
He cannot hope to reap the best
Who spends his time in play;
Achievement grants desire in time
To everyone who works,
Just so, the laws of life withhold
Success from him who shirks.

The reward of a thing well done is to have done it.—*Emerson.*

Difficulties are the things that show what men are.—*Ben Franklin.*

One reason why some people do not have more is because they do not want more.

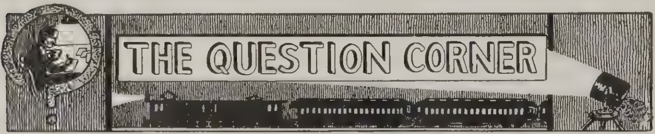
No man is more than another unless he does more than another.

The man who cannot praise the institution of which he is a part, discredits himself and his work.

Enthusiasm is one of the greatest forces in life.

Work was always man's best friend. Leisure is a very pleasant garment to look at, but it's a bad one to wear.

A well-prepared mind hopes in adversity and fears in prosperity.



Answers to Questions

1. *I would be pleased to have some suggestions for charging an ordinary automobile accumulator which I have. The available supply is* 110 *volts alternating current, which sometimes varies and reaches a higher value—J. L.*

Electrolytic Rectifiers

1. In answer to J. L.'s question regarding the charging of automobile accumulators, there are several ways available—a small generator set—mercury vapor rectifier—electrolytic rectifier—or electro-magnetic rectifier. If you do not wish to go to the expense of buying one of these, it is an easy matter to make an electrolytic rectifier. Obtain four quart glass jars, four pieces of aluminum rod, one-quarter inch or more thick and as long as the jar is deep, four pieces of sheet lead about 6 in. x 2½ in. and ⅛ in. thick. Make a wood box to hold the jars, keeping them about one inch apart. Bore holes in the cover—two holes over each jar about two inches apart. One hole is used to pass the aluminum rod into the jar and the other is used to take the wire leading to the lead sheet. Dip the cover into boiled paraffin wax and then connect and arrange the several parts, as shown in Fig. 1. To reduce the 110-volt alternating current, it is best to use a lamp bank, as shown in Fig. 2. The electrolyte used is a concentrated solution of ammonium phosphate.

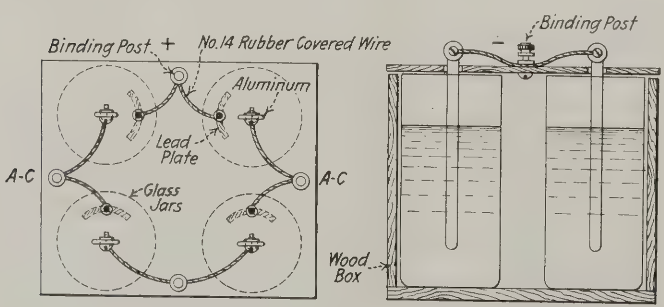


Fig. 1

A. H. M.

* * *

A slightly different method of accomplishing the same result, but one in which the theory is identical, is as follows:

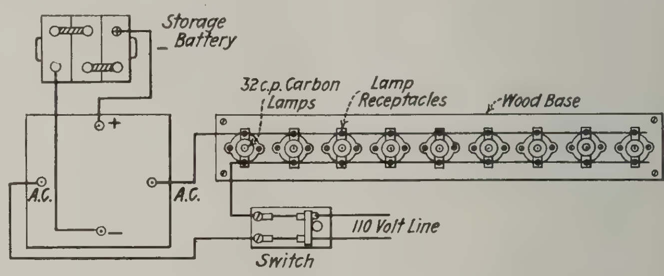


Fig. 2

A large fruit jar with the top cut off straight will answer for the container. This should be fitted with a turned wooden top or cover. A piece of lead pipe about three-quarter inch less in diameter than the inside of the jar is required. This lead pipe or cylinder should have nearly the same length as the jar. It should be flared out at the bottom and a row of quarter-inch holes drilled all around about one-half inch from the lower edge. Around the top of the cylinder a corresponding row of one-quarter inch holes is also drilled. A hole is made in the top of the lid at the center to take a fibre bushing four inches long and through this bushing, a piece of aluminum rod is passed until it reaches nearly to the bottom of the jar. The construction and circuit arrangement of this type of rectifier is shown in Fig. 3. By using four of these cells, both cycles of the alternating current are rectified. An ammonium phosphate solution may be used. To be sure, this type of rectifier is not as efficient as some other kinds which are more expensive, but it does have the advantage of being cheap and easy to build.

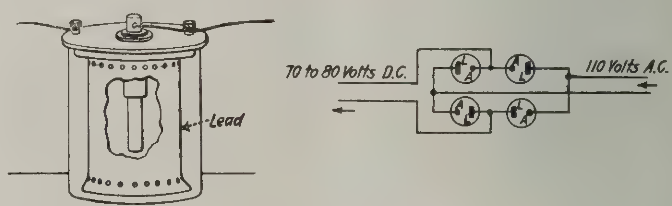


Fig. 3

* * *

Questions for March

What do you think is the probability that some form of direct drive for car lighting generators will supersede the commonly used belt drive within the next few years?—A. O.

What is the best method for using a voltmeter to measure voltages outside the range of its scale?—M. M.

NEW DEVICES

Gantry Crane for Heavy Freight

An electric gantry crane has been erected by the Niles-Bement-Pond Company in a busy freight yard near New York, as shown in the illustrations. This crane, embodying modern features of construction throughout, covers three tracks with two driveways, approachable from either direction, with trackage space for 15 cars at the crane. With a lifting capacity of 40 tons, the crane furnishes ample facilities for handling heavy freight, such as structural iron, building materials, machinery, boilers, steel freight containers, transformers, etc. An auxiliary hoist is previded, having 10 tons' capacity.

Gantry Crane with Cantilever Extension Placed in Raised Position

The span, center to center of the runway rails, is 49 ft. 3 in. With the cantilever extension at one end, the effective reach of the main hoist is increased 19 ft. 6 in. and the effective reach of the auxiliary hoist 21 ft. 11 in. The lift of the hook above the runway rails is 23 ft. The main and auxiliary hoist motors are each 50 hp. The trolley and bridge motors are 10 and 50 hp. respectively. The speeds with maximum full load are: Main hoist, 10 ft. per min.; auxiliary hoist, 40 ft. per min.; trolley, 100 ft. per min., and bridge, 80 ft. per min.

The cantilever extension is of the elevating type, being motor-operated from the cage, and is readily elevated to clear any obstruction. Platforms are furnished on both girders running the entire length, including the cantilever extension. A platform is also placed at the top of the shear legs for access to the cantilever elevating mechanism and one on each side of the trolley, which is enclosed for outside service, as is also the cage. The top of the trolley housing is arranged so that any part can be opened on hinged joints. allowing easy access to the trolley mechanism for oiling, etc., or the entire house can be easily removed. The cross platforms are easily lowered on hinged joints, allowing unobstructed access to main and auxiliary hoist drums and gears.

The trolley frame is a self-contained built-up steel structure, with all the mechanism and motors mounted. The trolley is designed to incorporate such improved features of construction as complete lubrication, large wearing surfaces, ample strength and rigidity, self-contained units, easy accessibility and easy handling. The cage is of plate steel construction, special provision being made for mounting the controlling apparatus with concealed wiring. The back of the switchboard is reached through large doors, which, when opened, expose the entire board, allowing ready access to all wiring connections. The crane travels on eight wheels, four at each end, two wheels at each end being driven through carefully guarded gearing.

New 40-Ton Niles Gantry Crane Unloading Container Car Section

The installation of cranes of this type insures the prompt

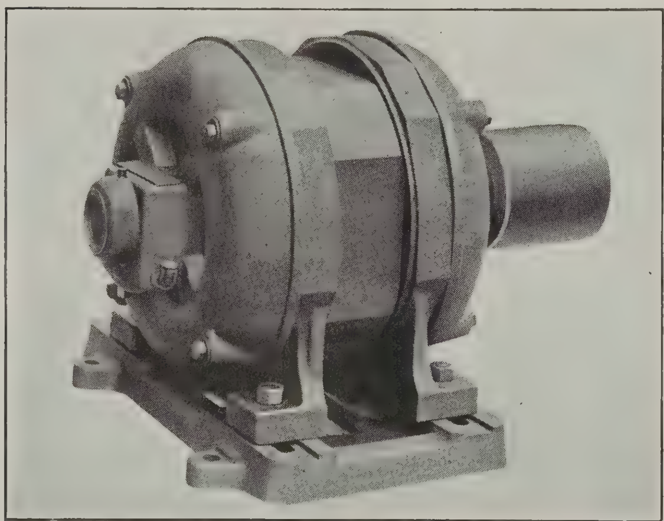
unloading and placing on trucks of all classes of heavy freight from any one of 15 cars available in the shortest possible space of time, thereby solving in a large measure freight congestion at terminal warehouses. There is an important saving of time and cost in handling heavy freight, and in addition it is moved more promptly to the consignee's premises.

Induction Motor With One-Piece Rotor Winding

A new induction motor designated as L-A type H. D. has recently been marketed by the Louis Allis Company, Milwaukee, Wis., which has a one-piece rotor winding. The entire winding of the rotor consists of an integral sheet of copper, punched and formed by a special mechanical process. This one-piece winding is machine wrapped around the rotor core, the copper bars being expanded into the core slots by swaging.

The single joint, which extends through the two end rings, is silver welded, after which the metal at both connections is processed by means of a contracting operation that rehardens the copper at the point where the heat, applied during the welding, softened it. This treatment results in a lapped, silver-welded joint of high strength.

The rotor winding is fabricated of comparatively thin

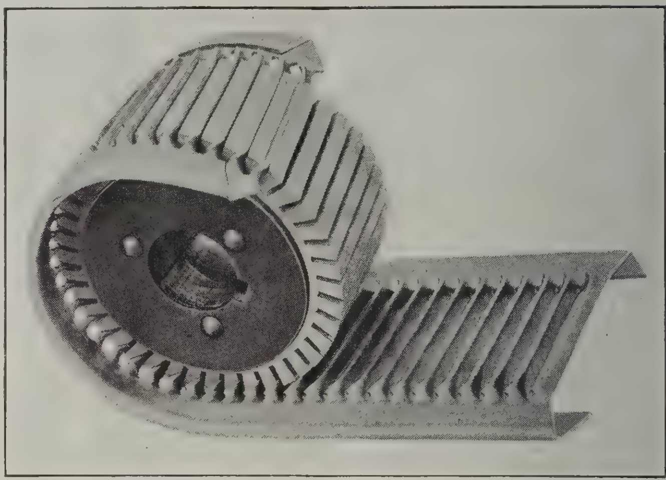


A Lewis-Allis Type H. D. Motor

copper stock, which has a high thermal conductivity and which conducts the heat generated in it toward the ends of the rotor bars where this heat is dissipated through the action of the malleable iron fans. The rotor bars themselves also constitute an efficient blower, thus materially increasing the ventilation.

The rotor core is a self-contained unit and may be pressed on and off the shaft readily as it has a straight keyway. In other respects the motor is largely conventional except that it employs open slots without the usual overhanging tooth tips. The manufacturers' experience has shown that so long as a suitable relation is maintained between the air gap and slot width the performance does not suffer as regards power factor and efficiency, and that a rotor core of this construction, with a suitable winding results in exceptionally high starting and running torques. These abnormally heavy starting and running torques have led the manufacturers to increase the shaft size over and above the usual practice for a given rating which, in combination with the liberal bearings, fabricated from a phosphor bronze, should insure long life in service.

All motors are guaranteed to carry their full rated load continuously with a temperature rise not exceeding 40 deg. C., and after their ultimate temperature has been



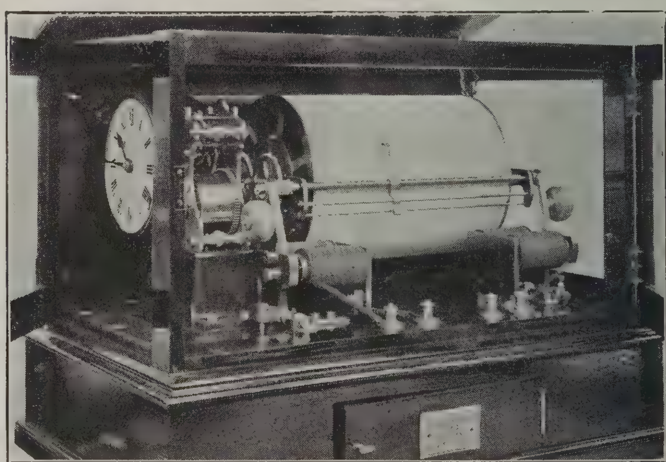
The One-Piece Winding Partially Applied to the Rotor

reached, to carry 25 per cent overload for two hours with a temperature rise not exceeding 55 deg. C. The motors are made in standard industrial sizes, voltages and frequencies.

Automatic Train Recorder

A machine for recording the time of passage of trains over a given point was developed recently by a Scotch firm for use in India.

The operation of the machine is quite simple, the record taking the form of a zig-zag curve drawn on the paper of the drum shown. The drum is of gun metal. It revolves on



Glenfield and Kennedy Train Recorder

horizontal bearings and is driven by a powerful spring clock, the mechanism of which can be seen to the left. In front of the horizontal drum is a long screw, geared to the clock, which moves the pen slowly across the paper. Thus the line, drawn longitudinally by the revolution of the cylinder and laterally by the action of the screw, becomes a diagonal line, indicating time. The movement of

the pen is uniform except when disturbed by the passage of a train.

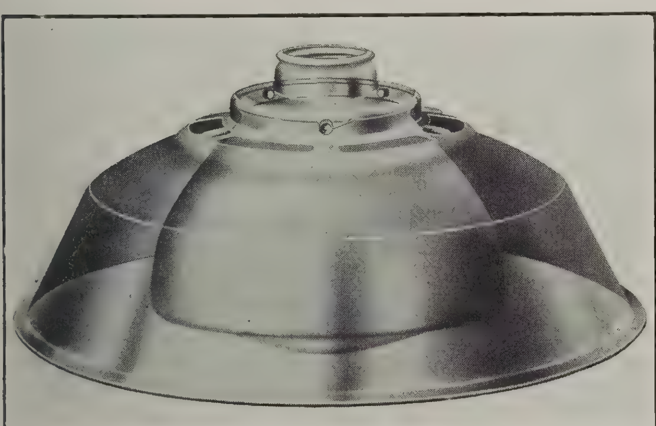
The pen carrier is controlled by the electro-magnets shown. By means of a suitable contact at a fixed point on the track, and a corresponding contact on the locomotive, each time an engine passes the point one or other of these electro-magnets is energized, according to the direction in which the engine is moving. When contact is made by the engine, current from the local battery energizes one magnet and the armature is drawn over, the pen carriage being thereby pulled over in the same direction. If the train movement is in the opposite direction the other magnet is energized and the pen is moved in the opposite direction.

The resulting diagram gives a complete record of train movements at the point, the record being exact to within 30 seconds of the actual time of passing; while the nature of the irregular mark shows the direction in which the train was going. The instrument can, of course, be used to give indications at a distance, and it can be safely housed in an office remote from the track.

The recorder was made by Glenfield & Kennedy, Ltd., Kilmarnock, Scotland.

Industrial Lighting Unit

A new industrial lighting unit, known as the Ivanhoe Glassteel Diffuser, has been developed by the Ivanhoe-Regent Works of the General Electric Company, Cleveland, Ohio, which is a modification of the R. L. M. (Reflector and lamp manufacturers') standard dome reflector. The unit combines several of the advantages of both steel and glass reflectors and consists essentially of a dome type steel reflector inside of which and inclosing the lamp is a glass diffusing globe. Six openings arranged in a circle near the center in the top of the steel reflector permit enough light to be given off in an upward direction to light the ceiling. The steel reflector protects the glass inclosing globe, minimizing the likelihood of breakage and the reflector directs the light downward to the working plane more efficiently than does an inclosing globe without a reflector.



Phantom View of the Ivanhoe Glassteel Diffuser

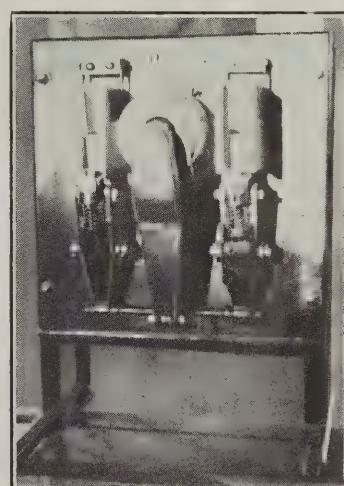
The reflector is made in two sizes of 18 and 20-in. diameter, respectively. The 18-in. unit has a 2¼-in. neck to take a medium screw socket and can be used with a 100, 150 or 200-watt lamp. The 20-in. size is equipped with a mogul socket for use with 300 or 500-watt lamps. By using a standard socket adapter, 150 or 200-watt lamps can be used in the 20-in. unit. The adapter lowers the light center so that it practically coincides with the light center of the 300 or 500-watt lamps, thus avoiding a distortion of the light distribution.

The disadvantages of the glassteel reflector as compared with the R. L. M. standard dome are that it distributes from 5 to 10 per cent less light on a horizontal plane, that there is an extra glass part to clean, and that the first cost of the unit is about double that of the R. L. M. standard dome reflector.

The advantages of the glassteel reflector as compared with the R. L. M. dome are as follows: More light is diffused at high angles by the glassteel diffuser which provides for better lighted sidewalls, the ceiling is lighted, the amount of glare is reduced by virtue of the large diameter light source; a bowl-enameled lamp is not required.

Automatic Switch for Protecting Welders

The automatic switch shown in the illustration was devised for the purpose of protecting electric welding operators working on direct current circuits which are subject to high open circuit voltage such as welding apparatus which employs a ballast resistance working from 250 or 500-volts direct current circuit. The switch is manufactured by the Electric Arc Cutting & Welding Company, 152 Jelliff avenue, Newark, N. J. By means of a pilot circuit, the switch in the main circuit is open until the electrode is touched to the work. The main switch then closes and remains closed until some predetermined value of voltage across the arc is reached, at which time the main switch again opens. The device consists essentially of a magnetically operated switch and a potentiometer mounted on a slate panel supported by an iron frame. The manufacturer's claims for this apparatus are that it holds low voltage on the welding handle and ground lead while welding is in progress, that these parts are practically dead when not in use and that the ugly flare and deep crater which occur when high voltage direct current is used for welding are done away with automatically.



Protective Switch for Direct Current Welding Circuits

Refillable Plug Fuse

A refillable plug fuse of the Edison base type has recently been placed on the market by the Martindale Electric Company of Cleveland, Ohio. The refill element consists of a small conical shaped metal piece with fuse wire leading from apex to cone. This wire is threaded through a hole in the bottom of the plug and secured to a binding screw in contact with the outside.

General News Section

The Gibbs Instrument Company, Bay City, Mich., manufacturers of electric welding equipment, has opened a sales office in the General Motors Building, Detroit, Mich., in charge of F. M. Luchs, formerly chief engineer for the company.

Hall Brothers Cedar Company, Coeur d'Alene, Idaho, announces the removal of its general office from Jacksonville, Tex., to Coeur d'Alene, Idaho, where it will engage in the manufacture and sale of western red cedar post poles and piling.

Work on the first high voltage porcelain insulator works to be built west of the Mississippi river has been begun at Emeryville, Cal., near San Francisco, by the Westinghouse High Voltage Insulator Company, of Derry, Pa., a subsidiary of the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa.

Electrification is being considered for the Grand Trunk main line between Toronto and the Niagara frontier, and also for the old Canadian Northern line between Toronto and points on the Ontario Lake Shore as far east as Cobourg, Ontario. Should this electrification be decided upon, the Grand Trunk main line would continue under steam operation.

Several changes in the branch offices of the Westinghouse Electric & Manufacturing Company have been announced by W. S. Rugg, general sales manager. C. V. Woodward has been appointed manager of the Baltimore office, and F. C. Reed has been made manager of the Huntington office. R. J. Ross has been appointed assistant manager of the transportation division of the Philadelphia office, and W. F. James has been appointed manager of the industrial division of the Philadelphia office, succeeding R. F. Moon, who has resigned to accept the vice-presidency of the Atlantic Elevator Company, of New York.

The Long Island Railroad has purchased one 4,000-kw. and one 3,000-kw. six-phase, 25-cycle, 650-volt rotary converter with the necessary transformers from the Westinghouse Electric & Manufacturing Company for the purpose of increasing the sub-station capacity of the railroad. This increase of capacity was necessitated principally by the addition of 40 motor cars and 20 electric trailer cars for suburban service, noted in the January issue of the RAILWAY ELECTRICAL ENGINEER. The Westinghouse Company will also supply the electrical equipment for the cars. The order for cars included four baggage mail cars not mentioned in the January notice.

The General Electric Company and the American Locomotive Company have announced that they have entered into an agreement providing for close co-operation between the engineering organizations and manufacturing facilities of the two companies in the design and manufacture of electric locomotives for use on steam or electric railways. In making the arrangement at this time, both companies have been influenced by the increased interest and business in railway electrification, both in the United States and abroad, which is manifesting itself and which indicates a considerable volume of work of this character in the near future. The arrangement relates only to co-operation in design, development and manufacture, and does not comprehend any financial relationship between the two companies.

According to the "Pennsylvania Standard," published by the Pennsylvania Railroad, Charles N. Cromwell, pumper at Summit, Indiana, on the St. Louis division, has never missed a day on duty in over 52 years and his locomotive water supply has never failed. He was retired on pension last December after 52 years, four months and eleven days continuous service. Mr. Cromwell was born in Indiana and most of his boyhood days were spent in hauling ties and cord wood for the wood burners used in those days on the Terre Haute & Indianapolis. He was employed on July 21, 1870, as a pumper at Reelsville, Indiana, and in 1899 was transferred to Summit. During the 52 years, four months and eleven days of service, he has never missed a pay day and has worked every Sunday and holiday. It is his boast that he never sat down and waited for repairmen from headquarters, and that consequently no engine ever stopped at his station without getting water. He calculates that he has pumped about 780,000,000 gallons of water, enough to fill a tank 16 ft. by 20 ft. 65 miles high.

Co-operation of I. C. C. and Train Control Committee Terminated

The Interstate Commerce Commission has directed that the co-operation of its Bureau of Safety with the Joint Committee on Automatic Train Control of the American Railway Association in the investigation and tests of automatic train control apparatus be terminated. This information was conveyed in a letter from W. P. Borland, chief of the Bureau of Safety, to President Aishton of the American Railway Association, stating that "the period provided for intensive tests having expired on January 1, 1923, and the carriers now being required by the commission's order to 'proceed without unnecessary delay to select and install the devices as specified' it does not appear that any material advantage can result from the further close co-operation of the bureau with the A. R. A. Joint Committee on Automatic Train Control" and that the commission has, therefore, directed that this portion of the work be concluded. It was further stated that field work in progress in connection with the joint tests would be discontinued on January 31 and that the records and reports would be completed as early as practicable. The letter pointed out that the period between the date of the train control order of June 13, 1922, directed to 49 roads,

and January 1, 1923, was expressly for such tests as the carriers desired to make preparatory to making their selection and that the two-year period from January 1, 1923, to January 1, 1925, was provided in accordance with the law in which to make the actual installation, which is to be completed by that time.

The Interstate Commerce Commission on January 30 announced its denial of the petition of the Chicago & Eastern Illinois for a modification of the requirements prescribed in its train control order so as to authorize it to employ permissive operation (leaving the engineman free to forestall application of the brakes) of the Miller automatic train control system, in use on its line, in the way it has been used hitherto.

Power Supply for West Jersey and Seashore

The Philadelphia Electric Company has purchased from the Westinghouse Electric & Manufacturing Company three 6,000-kw., single-phase frequency changer sets to comprise the initial installation in its Somerset substation for the supply of 25-cycle energy for operation of the Camden to Atlantic City, West Jersey and Seashore division of the Pennsylvania Railroad. At the present time this railroad is operated at 600 volts d. c. by power supplied from its own power house, the energy being transmitted to various substations where it is converted to 600 volts d. c.

The frequency changers will also be able to supply single-phase load. The 25-cycle, 13,600-volt end, which will operate for the present at 6,000 kw., 90 per cent power factor, will be good for 6,000 kw., 80 per cent power factor single phase. The 60-cycle motor is arranged for 90 per cent power factor leading and is also 13,600 volts. There will be a common exciter for both ends of the sets.

The sets will have a one-minute load capacity of 200 per cent of normal kilowatt rating and will be capable of withstanding swings between no load and this value of load without dropping out of synchronism. The frequency changers will be equipped with a motor-operated frame shifting device for synchronizing and loading purposes, and each unit will be provided with an automatic voltage regulator. The voltage regulators will have short circuiting devices. The frequency changers will be arranged for alternating current self-starting, two three-phase auto transformers being provided, each of which is capable of starting three sets in succession.

New Data on Dry Cells

The recently adopted standard sizes and tests for dry cells and flashlight batteries, together with much additional data, are given in a revised edition of Circular 79 issued by the Bureau of Standards. These tests and sizes were adopted by a conference of the leading manufacturers, government representatives, and the largest individual users which met at the Bureau of Standards in December, 1921.

The electrical theory and construction of various kinds of dry cells are given in this circular, together with a discussion of the various kinds and the types of service for which they are intended. About half of the circular is devoted to a discussion of the electrical characteristics of dry cells, including their behavior in circuit; the internal resistance of dry cells; method of grouping cells; effects of temperature on the voltage, current, and capacity; and the capacity of dry cells discharging under various conditions of service.

Standard tests for dry cells are described, and specifications for the performance of the standard sizes of cells and batteries are given in the appendix.

This circular, entitled "Electrical Characteristics and Testing of Dry Cells," may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., by asking for Circular 79 (second edition). Price, 15 cents.

Large Transformers for French Railway

Chemins de Fer de Midi, France, has ordered from the Westinghouse Electric & Mfg. Company twenty-five transformers rated at 6,667 kva. each, for 50-cycle system. These transformers are going to be used on a nominal 150,000-volt system which is to be the voltage adopted for the new national transmission system. It is the highest voltage thus far used in Europe. The transformers are of the shell type and are arranged to be cooled by forcing the oil through external coolers.

Eleven of these transformers are step-up units designed for connection in 20,000 kva., three-phase banks to raise the voltage from 60,000 volts delta to 154,000 volts star. Four 2½ per cent taps are provided in the low voltage winding.

The remaining fourteen transformers are designed to step down from 154,000 volts star to 60,000 volts delta. They are larger than the step-up units, for they include 5,333 kva. tertiary windings which will be used to provide 16,000 kva., three-phase, at 6,600 volts for the operation of synchronous phase modifiers. Four 2½ per cent taps are provided in the high voltage winding with no taps in the 60,000 volt winding.

Each transformer will have its own pump and its own oil cooler of the tubular type in which the oil circulates around the tubes and the cooling water flows through the tubes in the opposite direction. The oil circulates at the rate of 110 gallons per minute and the water at the rate of 53 gallons per minute.

Brazilian Electrification Credit Authorized

Authorization has been granted by the state of Sao Paulo, Brazil, for a credit of 1,297,418 milreis (milreis equals 54.6 cents at par) to be used for electrification of the Campos do Jordao Railway, according to Assistant Trade Commissioner Cremer at Rio de Janeiro.

Electric Operation for C., M. R. & S.

The Columbus, Mineral Range & Southern, which was recently organized at Columbus, Mont., with F. M. Post as chief engineer, will construct 80 miles of track from Columbus along the Stillwater river in a southwesterly direction, into a new mining district. Trains will be operated by electricity. Contracts for grading will be let about May 1 and for track laying about June 1. One bridge 500 ft. long and seven bridges from 60 ft. to 80 ft. long will be constructed. Terminal facilities and office buildings will be constructed at Columbus, as well as other necessary structures along the right-of-way. Rolling

stock and motive power will be purchased in July and August, according to the plans of the company. The principal commodities which the road will carry are minerals, including coal, and farm produce.

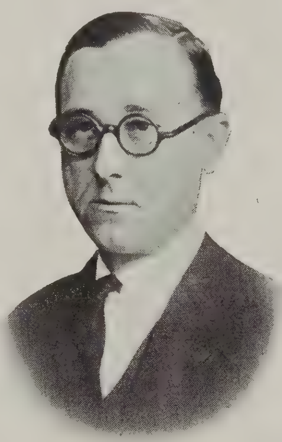
Personals

R. J. Ross has been appointed assistant manager of the transportation division of the Philadelphia office of the Westinghouse Electric & Manufacturing Company.

Edwin L. Andrew has been appointed assistant to manager of the department of publicity of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa.

Harry S. C. Folk and Donald Weaver have joined the railway department of the Electric Storage Battery Company as assistants to Howard S. Mills of the New York office. Mr. Folk was previously in charge of the industrial truck and locomotive department and Mr. Weaver was formerly connected with the general office staff in Philadelphia, Pa.

R. E. Gallagher has been appointed assistant electrical engineer of the Louisville & Nashville with office at Louisville, Ky., effective January 15, 1923. After finishing college, Mr. Gallagher received his early training in the electrical department of the Baltimore & Ohio Railroad Company where he was employed for a period of about 10 years. Later he engaged in electrical contracting work in the cities of Norfolk, Va. and Baltimore, Md. For about four years, ending in 1918, Mr. Gallagher was first assistant electrical engineer of the Seaboard Air Line. In 1918, he was appointed electrical engineer of the Seaboard and just prior to accepting his present position, he was sales engineer for the Middle West district of the Stone Franklin Company.



R. E. Gallagher

Trade Publications

Lighting Fixtures.—Catalogue No. 27, published by the Faries Manufacturing Company, Decatur, Ill., is an illustrated book of 120 pages, describing the complete line of electric brackets, portables, metal shades and reflectors manufactured by that company.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has recently issued a 14-page illustrated bulletin entitled Advantages of Railroad Electrification. The pamphlet, which is known as reprint No. 128, sets forth statistics and data acquired from actual operating records on both steam and electric roads as a means of comparing the two methods of operation. These statistics touch on fuel consumption, maintenance costs, schedule possible under existing modes of transportation and other subjects of importance. The feasibility of electric operation in tunnels, on heavy mountain grades, in congested freight yards, or heavy interurban traffic, are also clearly set forth.

Electric Snow Melters.—Electric snow melters of an improved type, for the purpose of preventing the accumulation of snow and ice at switches and other places where the free movement of mechanism is essential in keeping trains moving, are described in a four-page illustrated bulletin issued by the Q. & C. Company, 90 West street, New York, N. Y.

Yard Lighting.—Ivanhoe Lighting Equipment for Railroad Service is the title of a 15-page illustrated catalogue issued by the Ivanhoe-Regent Works of the General Electric Company, Cleveland, Ohio. The catalogue includes recommendations for lighting a typical classification yard, and describes and illustrates various types of lighting units for this class of service.

Publication 3015 is an illustrated 24-page booklet on C-H Lifting Magnets—featuring the "Red" Magnets—being distributed by the Cutler-Hammer Manufacturing Company, of Milwaukee. The features of the Red Magnets are fully illustrated and described—such as the heavy outer pole shoe of massive flange construction and the protected pockets for bolt head in both the inner and outer pole shoes. The new heavy-skirted "Red" Magnets are made in the following sizes: 39 in., 45 in., 55 in., 65 in., although 18-in. and 24-in. magnets are still included in the line. Special mention is made of the method of control and the C-H Magnetic Controller and Master Switch furnished with Cutler-Hammer Magnets, and the numerous illustrations give evidence of the many and various applications of lifting magnets today.

General Electric Company, Schenectady, N. Y., recently issued three bulletins Nos. 46108, 47002 and 44018. The first bulletin describes the type M-4 demand meter, which is designed for use in combination with a watthour meter to indicate maximum demand. The watthour meter indicates the fluctuating values of load and causes the pointer of the demand registering mechanism to advance by increments, in step with it, through the agency of a contact device in its register. The windings of the M-4 demand meters are adapted for a maximum of 240 volts and can be furnished self-contained for use on all standard frequencies. This meter is not recommended for intervals of less than 15 minutes. Bulletin 47002 treats of panels and supporting frame-work. Plate and marble are the two materials mentioned as being universally used for switchboard panels. The standard heights vary from 16 in., single section panels mounted on supports, 48 in. to 99 in. high; panels in three sections on supports, 99 in. high. All panels have ⅜ in. bevel. The third bulletin is somewhat more elaborate with cover design printed in colors. The title of this bulletin is Metropolitan Subway and Elevated System. The facilities for power production, transformation, transmission and utilization are outlined briefly for each of the systems in the cities of Boston, Chicago, New York and Philadelphia.

Railway Electrical Engineer

Volume 14 APRIL, 1923 No. 4

The June Convention of the Association of Railway Electrical Engineers will not be held this year. This decision was reached by the executive committee after it had become known that there would be no exhibits on Young's Million Dollar Pier in Atlantic City. There is no question but that the exhibits form one of the most valuable features of the semi-annual convention of the electrical men; but it is to be regretted that the opportunity is lost for at least some kind of a get-together meeting of those engaged in the rapidly growing field of electrical applications in railroad operation. As the old saying goes, "There is no great loss without some small gain," so that while there will be no exhibits this year, the chance for a larger and better line-up of exhibits next year is practically assured. By the same token, the omission of the convention in Atlantic City will make the October Convention of the A. R. E. E. all the more valuable. Committees should make good use of the intervening time in order to present the very best possible reports, for the work of the electrical engineer is broadening out to such an extent that he is being hard put to keep informed in the innumerable matters which have a claim upon his attention.

June Convention Omitted

Comparatively little attention is being given to the subject of train control by the electrical men in the electrical and mechanical departments. There is great activity in this field, however, as is apparent by the great number of new and improved devices which are being developed.

Train Control Development

The initial work has fallen logically enough upon the signal departments, for before any system can be generally adopted, the question of how train control and cab signals can be used to greatest advantage must be decided upon by the operating and signal departments.

The point that is apparently receiving insufficient consideration is that, with the majority of systems available, the bulk of the equipment is not located on the roadbed, but is on the locomotive. In most cases some form of electric power is required on the locomotive for the operation of the train control apparatus. This may be a storage battery, a generator or both. The headlight generator has been looked to as the logical source of energy and in response to this the manufacturers of headlight equipment have offered to supply generators with the necessary excess capacity or with an attachable auxiliary that will permit the generator to meet the additional demands.

As the control apparatus is on the locomotive and as it simply forms a part of the other electrical apparatus on the locomotive, the same maintainer will probably be required to look after both the lighting equipment and the electrical part at least of the train control apparatus. Because of these facts the *Railway Electrical Engineer* is describing the new and improved equipment as it is brought out. Space in this issue has been given this subject and more will appear in the May and succeeding issues.

Great progress is being made in applications of autogenous welding on the railroads. Examples of what is being done are set forth in the following statements made recently by a welding supervisor on a western railroad.

Fusion Welding Progress

"Many parts, such as cast steel castings, used on locomotives and cars today, when broken or worn, can be effectively repaired only by fusion welding. Such parts are used in abundance on present day equipment. One-piece truck sides and bolsters are typical examples. Their adoption effects considerable economy in maintenance, but is of much greater value when facilities such as arc welding are available, so that they may be reclaimed when defects develop or when they become worn. In fact with the aid of arc welding and annealing facilities, their life is practically unlimited.

This road now has in use about 80,000 of these one-piece truck sides and seldom ever are they damaged so bad that they cannot be repaired.

This is only one of many similar items which are reclaimed, others being fractured or worn cast steel couplers, knuckles, brake shoe heads, car door hangers, passenger car pedestals, steel wheels, flat spots and sharp flanges built up and many other parts, and also construction work.

In the locomotive shops some of the principal applications are welding boiler tubes to back flue sheet—this application is standard practice for application of flues to all engines as they pass through the shops. The performance of locomotives with welded flues has been so good as to be commented upon by all engaged with locomotive maintenance.

Some of the other arc welding applications are welding in firebox sheets and patches, cracks in fireboxes, broken frames, building up sharp flanges, and other applications too numerous to mention."

The name of the supervisor and of his railroad have been omitted as the *Railway Electrical Engineer* does not wish to subject him to undue questioning. Some of the practices mentioned are frowned upon. The fact remains, however, that all these practices are being carried on successfully on a large scale and the thing that remains to be done is to make such practice universally successful. Probably the best and most uniform results can be obtained by cooperation with the American Welding Society and the American Bureau of Welding. In 1922, the American Welding Society collaborated with the American Electric Railway Association on the welding of rail joints for street railways with gratifying results. This year the Society is prepared to handle steam road problems and will welcome questions and suggestions. This is an opportunity that should not be overlooked and railroad men will do well to solicit the assistance of the Society.

Radio for Train Operation

In recent years there is perhaps nothing that has so taken the country by storm as has the development of radio. So extensive has the use of radio receiving equipment become that the percentage of those who read this and who do not own a receiving outfit is remarkably small. Aside from the broadcasting feature of radio with which so many are familiar, there are other applications which may be of high utilitarian value, and the ones which should be of greatest interest to electrical men on the railroad are those which pertain to expediting of train movement. It is true that so far radio has not performed many unusual feats in this direction but there can be no doubt concerning the possibilities for its use when it has been improved a little more than it is at present. One of the places where radio can be used to advantage on some roads at least is in communication between the front and rear ends of long trains. Such a development hinges almost entirely on the perfecting of some simple form of transmitting equipment, for there are countless numbers of receiving outfits which could be used with complete satisfaction. Unfortunately, the great majority of railroad men who have been experimenting with radio have confined most of their thoughts to the receiving end so that while there are many unique receiving sets, there are comparatively few men who are acquainted with the radio transmitter. It is, however, a fact that the difficulties of radio transmission are in some measure dependable upon the distance over which the message is to be transmitted, and since the greatest distance to be considered in communication such as suggested would not be more than a mile, the problem should not be so formidable after all. Even a small 5-watt tube has been made to operate over many miles, and it should not be impossible to construct a radio transmitting set with such a tube, which would be entirely portable and not so very complicated. Some one of the many who are at present interested in radio will bring out such an outfit and when it has been developed to a dependable stage, it is almost certain to find a wide use in railroad operation.

There is perhaps one obstacle to the use of radio communication for this purpose and that is the United States law requiring that every transmitting station must be licensed and in charge of a licensed operator. It must be remembered that the radio telephone is a very recent development and that it has been difficult to frame regulations which will anticipate the new applications of this unique invention so that it is quite probable that existing laws may be modified.

Advancement by Examination

Among the many changes which are gradually taking place on the railroads, there is none which is more significant than the steadily increasing adaptations of electricity to railroad purposes. Railroads of necessity are being obliged to make use of labor saving appliances of every description and a very large percentage of these will be found to require the use of electric energy in one form or another. The natural outcome of this increased use of electrical equipment is that the men who must take care of the various kinds of apparatus must be of a higher order than has been required in former years. Efficient operation of electrical machinery will not permit its being handled by men who are not acquainted with such apparatus and for this reason, a more intelligent class of men are finding their way into railroad service. On the whole, it is a healthy development, for from the nature of electrical maintenance there will arise opportunities for men who are willing and anxious to study and fit themselves for higher positions. Under former practices the oldest employee stood in line for the highest rate of pay regardless of whether or not he was the most efficient man; but, with the advent of complicated electrical equipment, this rule must of necessity be somewhat modified. It is easy to see that it would be impossible to put valuable apparatus in the hands of an inexperienced man no matter how old he might be in point of service; moreover, the nature of electrical work is such that different degrees of responsibility may easily be established which, in turn, result in different rates of pay. This, too, is a healthy condition for it stimulates the man lower down the scale and gives him something to work for. As a result of this changed condition of affairs, the new method of appointing men to higher positions as vacancies occur is likewise developing. To find out whether or not a man is capable of performing the work required in a certain position, one of the best ways is to give him a rigorous test by means of a written examination. If he is thoroughly acquainted with the work, he will not have the slightest difficulty in making a very creditable showing in such a test. In fact, in the great majority of instances, the percentage attained is almost in direct proportion to the man's knowledge of the work. Of course, the questions asked in such an examination must be entirely unknown to the applicant, that is to say, no fixed set of questions which any applicant has had access to before would be of any value in establishing the rating of a man's knowledge about any particular kind of work. One very significant fact about examinations of this kind is that men who object to them are almost invariably those who are afraid they could not make a creditable showing. There seems to be much to recommend the examination system of advancement where officers are desirous of securing a high class corps of intelligent, trained, and trustworthy men, and it certainly gives the man who is willing to apply himself a chance to forge ahead in proportion to his ability.

New Books

Belt Conveyors and Belt Elevators. By Frederic V. Hetzel. Bound in cloth, 333 pages, 291 illustrations, 58 tables, 6 in. by 9 in. Published by John Wiley & Sons, Inc., New York.

This volume, contrary to the idea which its title might infer, does not treat the subject of material handling from the standpoint of where such equipment could be, or has been, used. On the other hand, it discusses the fundamental principles of the design and construction of belt conveyors and belt elevators or, as the author states in his preface, the details of the "how" and "why" of conveying and elevating by belts. It is essentially a book for the engineer who is concerned with this problem although it forms a practical reference for anyone who comes in contact with conveying machinery.

There are numerous chapters of interest to the railway man devoted to the design, construction and operation of equipment for use with bulk materials, such as coal, coke, ashes, ore, grain, sand, stone, etc., accompanied by references to and short descriptions of actual railway installations.

The New Mail Terminal Building Erected as a Part of the Chicago Union Station Project

Battery Charging at the Chicago Mail Terminal

Facilities Provide for the Charging of Tractor Batteries and of Batteries on Mail Cars in the Terminal

By W. Landess
Chief Electrician, Chicago Union Company

THE Chicago Union Station Company has installed complete battery charging equipment and shop facilities for the electric tractors used by the railroads for propelling the trailers that handle sacked mail on the loading and unloading platforms of the new mail terminal. Separate charging equipment and distribution circuits are installed for the charging of the car lighting batteries on the mail cars while spotted in the terminal.

Railroads Unload and Load the Mail Cars

Concrete platforms are built between the tracks just east of the building. Incoming mail is loaded onto the trailers, which are hooked up in trains and pulled by electric tractors into the building and onto the elevators. The trailers are removed from the elevators by post office employees on the different floors and dumped onto the belt conveyors system used for distribution and classification of sacked mail. Outgoing sacked mail is delivered by chutes to a platform on the track level floor. Union Station employees again take the mail at this platform, load it on the trailers, which are hooked up in trains, distribute it to the various car loading platforms.

Electric Tractors

Six of the initial fleet of eight electric tractors were furnished by the Mercury Manufacturing Co., while the two others were made by the Elwell-Parker Co. As the tracks and platforms are completed and the terminal develops to full capacity it is expected that at least 40 tractors will be required.

These tractors are equipped with 32 volt d.c. motors which are geared directly to the rear axle and wheels. A seat switch automatically cuts off the power unless the driver's seat is occupied, although normally the current is controlled by a hand lever operating a controller. A foot brake is also provided. The tractor is guided by a radial arm connected to the front wheels, which are 14 in. in diameter and are equipped with hard rubber tires.

The Tractor Batteries Are Interchangeable

The battery for each tractor consists of 18 cells of Exide "Ironclad" battery type MVX 300 a.h. capacity at 36 volts. The cells are constructed four in a tray, and the entire battery, together with a 300 a.h. Sangomo ampere-hour meter, is contained in a sheet iron carrier so as to form a unit that is interchangeable with the tractors. A chain hoist and dolly truck permits a quick change of battery, and the tractor need be out of service only a few minutes in order to get a fully charged battery.

A room is devoted exclusively to the maintenance and repair of these tractors and the charging of the batteries. (See Fig. 1.) On the south and east side of this room are located a total of 20 battery charging outlets, each provided with an indicating light which burns when the circuit is charging. On the west wall is an ammeter that can be connected into any one of the 20 circuits by means of a push button on the outlet.

The charging receptacle is located on the end of each battery unit. The charging cable extending from the outlet box has three conductors terminating in the plug. The ampere-hour meter has a small auxiliary contact so arranged that when the battery is fully charged and the meter indicates *o*, the contact is closed which completes the circuit of a shunt trip coil on the circuit breaker for that particular charging plug, thus cutting off the charge. One side of this control circuit is connected to the positive

lead at the battery through the auxiliary contact in the ampere-hour meter, and the other side is carried through the third contact in the center of the charging receptacle back to the shunt trip coil on the circuit breaker mounted on the switchboard and on through to the negative bus.

Switchboard and Charging Panels

The switchboard and generators are located in the room adjacent to that in which the tractors and batteries are maintained. The panels on which the control apparatus for charging is arranged are located on the east end of the switchboard, as shown in Fig. 2. There are twenty of these separate battery charging panels mounted four in a row and five rows high. Each panel is a separate piece of slate on which is mounted the circuit breaker, the automatic ammeter switch, a carbon pile resistance and a pilot light. See Fig. 3.

The single pole circuit breaker connected in the positive feed is mounted on the left. The battery charging circuit is made by pushing up on the handle until the contact

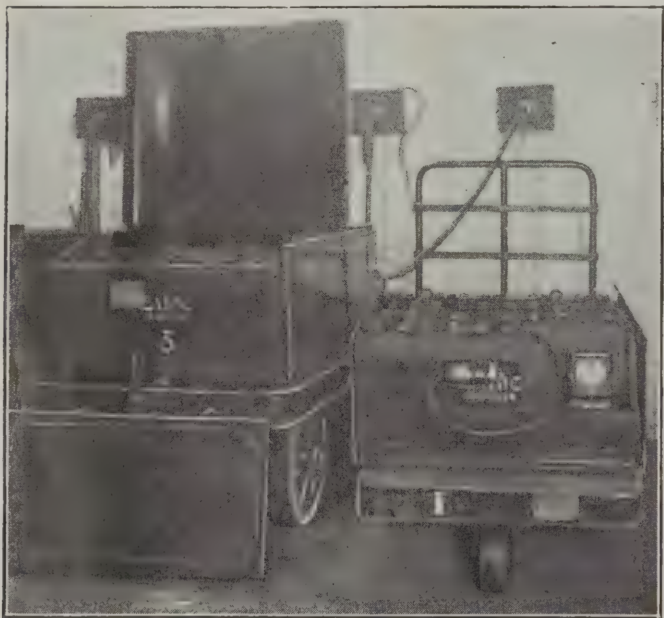


Fig. 1—On Left a Tractor With Battery Cover Open and Battery on Charge. On Right an Extra Battery Unit

is latched in the closed position. The device is equipped with an automatic overload trip coil connected in series with the load, that will automatically open the circuit on heavy current. A shunt trip coil and circuit is provided to trip this circuit breaker when the ampere-hour meter, mounted on the battery unit, registers *o*, indicating a full charge. The enclosed type Allen-Bradley carbon pile resistance unit mounted on the rear of the panel is adjusted by means of the hexagonal headed shaft extending through to the face of the panel. This resistance is adjusted to deliver an 18-ampere finishing charge to the battery when the electrolyte registers a specific gravity of from .1270 to .1280 for four consecutive 15 minute readings without any change. The adjustment is then semipermanently fixed by a set screw tightened on the shaft of the rheostat. With the constant voltage of 47.5 volts maintained on the bus bars battery will automatically take a tapering charge from, say, 80 amperes down to 18 amperes.

This voltage is maintained at 47.5 volts regardless of the load by means of a counter e. m. f. motor mounted behind the switchboard.

This counter e. m. f. motor used in connection with the voltage regulator is especially designed for this purpose. Its armature is connected in series with the field of the charging generator, while the field of the motor itself is energized from the base bars through an external re-

Fig. 2—East End of Switchboard. Tractor Charging Panels on Right

sistance. The counter e. m. f. motor is equipped with an eddy current brake consisting of a low resistance metal disc which rotates in a strong magnetic field produced by one or more magnets energized by the generator field current, and also the shunt circuit across the motor armature.

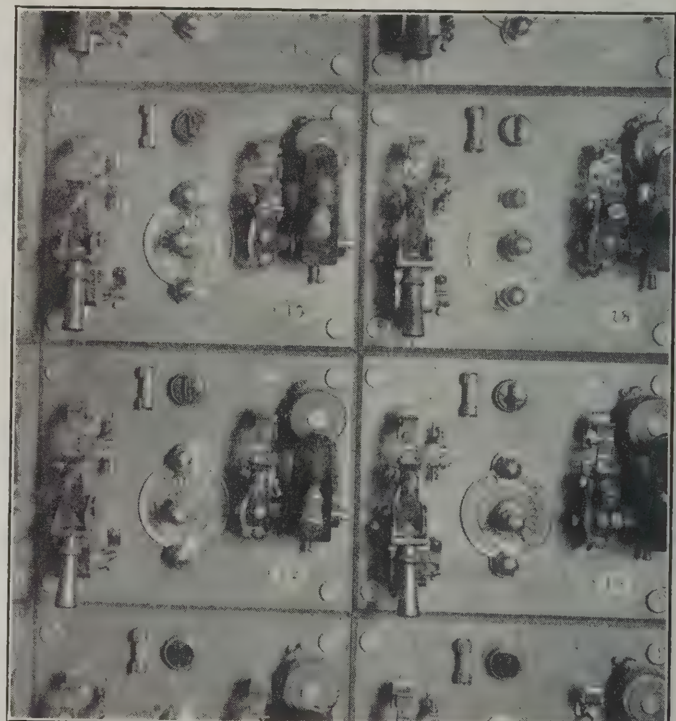


Fig. 3—Close Up View of a Section of the Tractor Battery Charging Panels

The brake is employed to prevent the motor from overspeeding and to give greater stability of rotation. The field of the counter e. m. f. motor is shunted by a resistance controlled by relay or regulator which is connected to the base bars of the main charging generator. The

voltage of the latter machine is adjusted so as to be about 10 volts above normal. As this generator voltage rises, the regulator opens the shunt across the field of the counter e. m. f. motor and permits full field to be applied to the motor, causing it to develop a high counter electro motive force. Inasmuch as this e. m. f. opposes that

Fig. 4—Car Lighting Battery Charging Panels

applied to the generator fields, excitation is constantly reduced and the generator voltage is decreased. The regulator again closes the shunt of the counter e. m. f. motor field, and maximum excitation is again applied to the generator field which tends to raise the voltage. This cycle of operation is continued at a high rate, the main

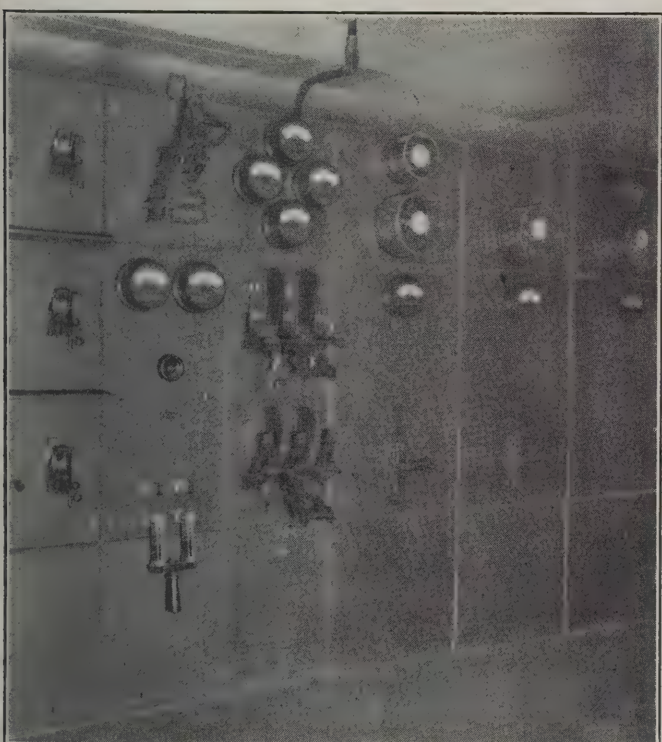


Fig. 5—The Panels for Switching the Power to the Motor Generators and for Switching the Direct Current Output From These Machines Are Located in the Center of the Switchboard

contacts vibrating at a rate of 500 to 800 times a minute. The charging rate at starting, of course depends on the condition of discharge of the battery. The continued charge of 18 amperes is said not to injure the battery even if the circuit breaker fails to operate in response to the circuit closed by the contact on the ampere-hour meter when full charge is indicated.

The automatic ammeter switch mounted on the side of the panel operates in response to a push button on the corresponding charging outlet in the battery room. This device operates a single-throw double-pole switch so connected in the circuit as to open the direct positive charging circuit and send the current through an ammeter shunt that in turn indicates the charging rate on the ammeter located on the west wall of the charging room common to all 20 circuits as mentioned previously. Release of the push button on the outlet panel, of course, releases this automatic switch and re-establishes the direct charging connection. This ammeter, although some 75 ft. from the switchboard, was furnished with calibrated leads so that readings on any of the 20 circuits are uniform. Each of these charging panels has a pilot light mounted behind a small red lense. The 0.5 ampere fuse on the face of the

Fig. 6—Motor Generator Sets Used for Battery Charging

panel is in the pilot light circuit. The 100 ampere fuses in the main charging leads are mounted in a row on the rear of the switchboard and near the bottom.

Car Lighting Charging Panel

On the left end of the switchboard is located the apparatus used for the charging of car lighting batteries of cars which are spotted in the mail terminal. As may be seen in the photograph (Fig. 4) the panel in the center contains the terminal receptacles of the 24 circuits that extend throughout the yard to outlets to which the car lighting batteries in the cars may be connected. The two outside rows of receptacles on each side are the terminals of the 16 charging panels which are located 8 on each side of the plug section. Connections between the feeder receptacles and the yard circuits are made by means of cord and plug connectors, not shown in the picture. These are all one wire connections and are all positive, the other side of the circuits being tied together in common. The 16 separate battery charging resistance units are mounted side by side on a separate slate block as shown, half on each side of the plugs. Each unit consists of a resistance and a circuit breaker. The current of the charging circuit is regulated by adjusting the carbon pile resistance extending to the rear of the board by operating the handle shown in front. The circuit breaker has an extra contact such, that by raising the handle above the normal closed

circuit position, that the regular charging circuit is cut through the common ammeter shown at the left of the switchboard. The circuit breaker is provided with an overload cut out coil that may be set to trip at various

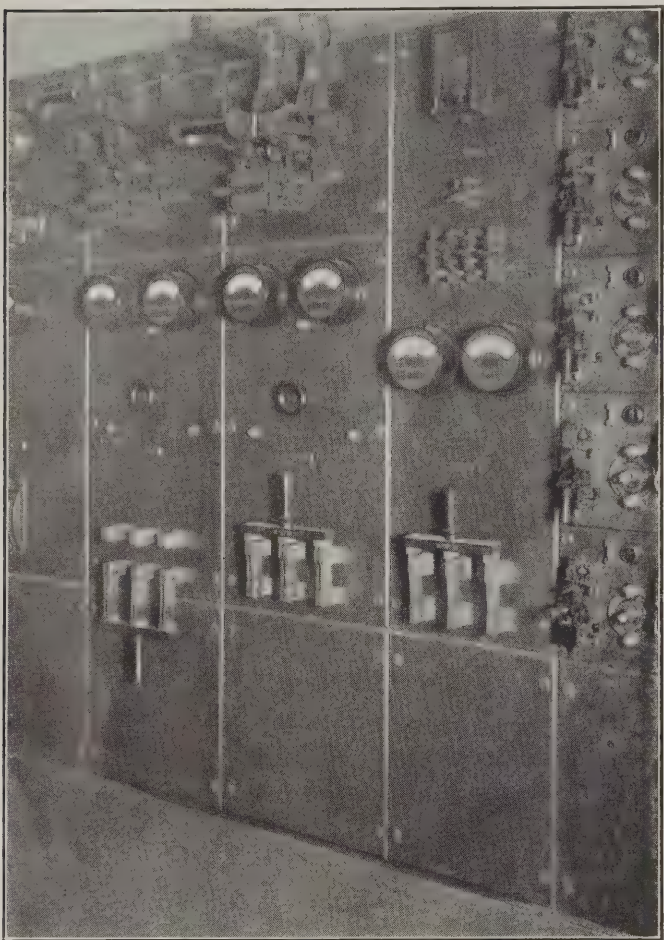


Fig. 7—Section of Switchboard Just to the Left of Tractor Battery Panel Which is on the East End of the Board

currents. Just to the right of this equipment is a panel of six single contact breakers, each of which provides a common negative for four of the separate car lighting circuits. The battery charging switchboard equipment was manufactured by the Allen-Bradley Company at Milwaukee.

Generating and Switching of Power

Alternating current power at 12,000 volts 3 phase is purchased from the Commonwealth Edison Company, and after passing through the power transformers is delivered to the three motor generator panels shown as the three panels to the right in Fig. 5, shown near the center of the complete switchboard. Each of these three panels has a starting compensator behind the switchboard, made by Allis-Chalmers Co., which is operated by the handle shown at the bottom of the board. This handle is thrown down for starting and up for running, the center position being open circuit. A 0-150 ammeter showing the input to each machine is furnished for each panel.

Motor Generator Sets

The motor-generator sets shown in Fig. 6 all have 75-h.p. 3-phase 440-volt a.c. motors, operating at 1,165 r.p.m. Two of the generators, that are used alternately for charging the tractor batteries, are 50 kw. capacity, three-wire generators at 50/100 volts. The third generator is a two-wire, 110-volt machine of 50-kw. capacity used for charging car lighting batteries. These machines and also the transformers were furnished by Allis-Chalmers Mfg. Co.

The 50/100-volt current of the three-wire generators is delivered to the 3-pole switch at the bottom of one of the two panels at the left end of Fig. 2. The rheostat above this switch is the field rheostat of the corresponding generator. The two d.c. ammeters are in the two legs of the three-wire system. The 2-pole automatic circuit breaker at the top of the panel is in the main feed to the busses of the small charging panels on the right end of the board previously described.

The panel at the left of Fig. 5 is of the same construction as Nos. 10 and 11, and is used for switching the energy from the 100-volt two-wire generator for the car lighting batteries.

The panel just to the left of the tractor battery charging panels in Fig. 2 has a switch for supplying three-wire d.c. power to the government post office for charging batteries. The voltage regulator for the installation is mounted at the top of this panel.

A Large Gravity Yard at Feltham, Near London

Electric Arc Welding of Thin Sheet Metal

Metropolitan Section of the American Welding Society Discusses Methods Involved in Joining Small Gage Material

AT a recent meeting of the Metropolitan Section of the American Welding Society the principal speaker of the evening was H. E. Wagner, of the Pittsfield (Mass.) plant of the General Electric Company. Although a great deal of Mr. Wagner's discussion was confined to the welding of thin sheet metal by various methods, he stated in the beginning of his talk that the title of his discussion really should be "Electric Welding, Old and New." In treating the subject, Mr. Wagner spoke in part as follows:

"When I was first called to make a short talk on the subject of electric welding, it took me back to the old days of the Emergency Fleet Corporation. It will be remembered that it was the welding branch of this corporation that succeeded in giving an impetus to the Welding Society and it was through the efforts of Comfort A. Adams, who was connected with the Emergency Fleet Corporation that the American Welding Society was formed.

"Since the organization of the society, welding has improved and the number of applications multiplied many, many times. Originally, metallic electrodes were little used and carbon electrodes were used almost exclusively in construction work. Now we have 62 welders in the Pittsfield plant of the General Electric Company and most of them are metallic art welders, and these men are busy in some of the departments night and day. These 62 men weld 100,000 ft. seams per month; they consume 12,000 lb. of electrodes; 5,500 carbon electrodes; 30,000 kw. of energy. These figures are fairly accurate. The Pittsfield plant is used for the construction of transformers and all of the various tanks used in the work are made at this point. All of our steel transformer tanks are electrically welded and hence you will see that welding is one of the main factors in our production. Although I have been asked to talk on the subject of 'Thin Sheet Welding,' I have chosen a wider subject. Later I would like to present some suggestions as to contruction work in welding forms in the blacksmith shop and also to review the construction of the arc welding of a steel box made in January, 1918, from which data was accumulated for the arc welding committee formed at that time.

Thin Sheet Welding

"Thin sheet welding was at one time considered very difficult, in fact it was thought that it was not possible of accomplishment. However, we have been able to weld 1/16-in. steel plate by the arc welding process, but it must be said that this is only done by making a special preparation of the steel. We upturn the edges of the plate and the welder draws his arc along the edge. So great is the amount of welding of this type in the construction of transformers that the total amount of such welded seams averages approximately a mile per day on steel tanks. All of these seams must be strong and tight against leakage of hot oil. Both hand welding and machine welding are done, the hand welder being capable of doing 130 ft. per day, while the machine has a capacity of double that.

"Most of our welding is done with direct current, but we have one alternating current machine that has proven satisfactory. We have not extended the use of alternating current, however, because we have such a large amount of direct current equipment which gives entire satisfaction.

"When it became necessary to produce a lap on 1/16-in. steel, the welder found it easier to take his carbon electrode and melt down the edge as he went along and at the same time melt in a filler rod. A piece of this welded material when subjected to a tension test will usually break outside of the weld. Eventually so much of the lap welding was required that we felt we would like to avoid feeding in the filler rod along with the carbon electrode and it ultimately developed that, as the welder became more skillful, he was able, in a large measure, to accomplish the work with the metallic electrode without the filler rod. No lap welding has been made on 1/32-in. steel, but it can be done on 1/16-in. plate.

"The carbon electrode used in this work is of taper design, being ⅛ in. at the small end and ½ in. at the large end. By using a carbon electrode of this type, the operator can concentrate his work where he desires and put in filler rods as needed. This type of an electrode is a decided advantage when the operator grows skillful in his work. It maintains its taper throughout its life. As it burns away, the taper is automatically maintained. One carbon pencil of this kind will weld about 10 ft. of 1/16-in. steel.

"Hand and machine welding can be done at various speeds, depending on the skill of the operator. Men trained in welding of thin metal cannot turn to thick metal and do it sucessfully. On the other hand, men who are accustomed to welding thick metal are unable to perform successfully the welding of the sheet metal. They must be trained on the particular work which they are to perform.

"Steel plates below 1/32 in. in thickness, we weld by using the electric resistance method and with this process of electric welding, we can go down as low as 14 mils thick. We have 13 machines operating in our factory, making welds of that character. It is done at the rate of 3½ in. per second and in the case of the double welding machine as fast as 7 in. per second. Three thousand amperes are used in welding this thin material. In welding 1/16-in. steel by the same process, 10,000 amperes are used and the work is performed at the rate of 36 in. per minute. The same speed can be attained with 3/32-in. steel, but in this case the current is raised to 11,000 amperes. This process is becoming more and more in use on thin sheet steel. Resistance welding on 1/16 and 3/32-in. steel is uniform and when subjected to test invariably breaks outside of the weld. If the work is properly done, the weld is 100 per cent tight and battering, hammering or chiseling on it does not tend to break it in any way."

At this point in his talk, Mr. Wagner introduced a large number of lantern slides showing the various types

of welded jobs that are encountered in the construction of large transformers.

A number of the pictures also showed the possibilities of building up dies of metal by the welding process to be used in making certain kinds of forgings. This particular phase of welding has been found extremely useful in the blacksmith shop, where a limited number of such forms are required because the expense involved in the building up of dies in this manner is very much less than when done in customary manner by making a pattern and then obtaining the usual casting. Not only is the cost cheaper, but the die made in this manner can be discarded after it has served its purpose rather than being filed away on account of the large expense involved in its making, which would be the case if it were a pattern-made die.

Immediately following the lantern slides a motion picture was shown illustrating the construction of a large sheet metal box which was constructed in June, 1918, and upon which a number of experiments were tried for the purpose of securing data for the arc welding committee at that time. The tank, after it was constructed was subjected to what was called a "breathing test," during which the tank was filled with water to a pressure of approximately 15 lb. to a sq. in. and then subjected to a vacuum of 22 in. of mercury. This test was repeated some 200 times. The motion picture showed clearly the rise and fall of the metal top, bottom and sides of the tank during the test, from which much valuable information was secured.

In addition to the lantern slides and the motion picture, Mr. Wagner had a large number of samples of welded sheet metal plates. These samples included welds made both by hand and by machine on sheet metal of various thicknesses.

A Few Questions

At the close of Mr. Wagner's talk, the chairman of the meeting suggested to the members that if anyone desired to ask questions that Mr. Wagner would be glad and willing to answer them. A few of the questions which were asked are as follows:

In connection with resistance welding machines, do you compensate for change in impedance of the circuit?

Answer—No compensation is required.

In continuous welding for punch piece operation, does not the weld spoil one of the stampings?

Answer—No. The welding sheets are overlapped about 1/32 in. and sufficient pressure is brought to bear so that the thickness at the weld is about the same as that of the sheet. Difference in thickness is hardly perceptible.

What are these punchings used for?

Answer—They are used in the cores of transformers.

On the welding of 1/16-in. plate lap weld with electrode what diameter of electrode do you use?

Answer—Usually 3/32-in. electrode, although some welders use ⅛ in. About 90 amperes of current is required.

In your opinion, what do you think will be the ultimate method used in welding sheet steel; will it be carbon arc or resistance welding for 1/16-in. metal?

Answer—I would say resistance welding.

Is resistance welding suitable for all shapes?

Answer—Machines must be designed for particular kinds of construction.

Would it not be safe to say that resistance welding would be adopted for large production and some other form be suitable for job lots?

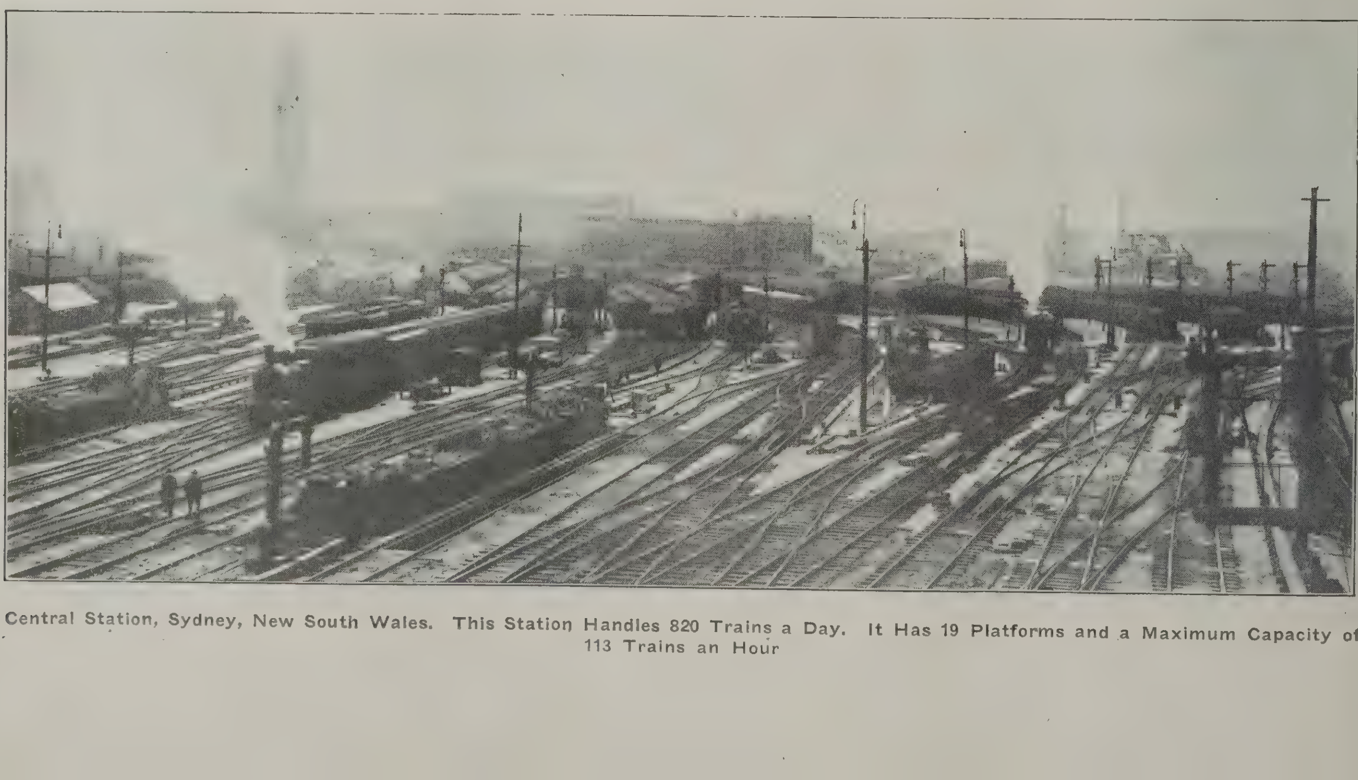
Answer—Yes, this is substantially correct.

Is resistance welding progressive or simultaneous?

Answer—Resistance welding is progressive welding.

Next to having no convictions, the next worst thing is hardened convictions, which have degenerated into prejudices. Sometimes the brain cells seem to set like concrete. To introduce a new thought requires a blasting operation.

Perhaps the first value that comes from thrift consists of the preparation it gives one for the future.



Central Station, Sydney, New South Wales. This Station Handles 820 Trains a Day. It Has 19 Platforms and a Maximum Capacity of 113 Trains an Hour

Southern End of Little Hell Gate Bridge on the New York Connecting Railroad

All-Electric Passenger Service for New Haven

Twelve New Electric Locomotives Will Eliminate Steam Passenger Locomotives on Electrified Section

By W. J. Clardy

General Engineering Department, Westingtouse Electric and Manufacturing Company

THE New York, New Haven & Hartford electrification embodies all classes of service on a trunk line railroad. The main line between New York and New Haven, Conn., a distance of 72 miles, is an example of what can be done by electrification on a congested four-track section with extremely heavy freight and passenger traffic. There are nearly 600 miles of electrified track, including some of the busiest main line and yard trackage in the world. Yards at Oakpoint, N. Y., and Westchester, N. Y., are served entirely by electric switcher locomotives.

The present electric motive power consists of 106 Baldwin-Westinghouse locomotives, 52 for passenger, 38 for freight, 16 for switcher service, and 35 Westinghouse equipped multiple-unit motor cars. The first 41 passenger locomotives, placed in service in 1906 and 1908, are the 2-4-4-2 type and weigh 102 tons complete. The last five passenger locomotives were built in 1919 and are the 2-6-2+2-6-2 type, weighing 180 tons complete. Sixteen 80-ton, 0-4-4-0 type switcher locomotives were placed in service in 1912, and 36 110-ton, 2-4-4-2 type road freight locomotives in 1912 and 1913. The first of the 35 multiple-unit motor cars were operated in 1909 and the last eight cars went in service in 1922. These cars range in weight from 84 to 91 tons complete with all equipment and without passengers. Each motor car is capable of hauling two trailer cars.

In 1916 and 1917 a complete study was made of the traffic requirements to determine what type of motive power was best adapted for the service. The original types of freight and switcher locomotives were considered suitable for handling the continued increase in this class of traffic. The first passenger locomotives which were built were satisfactory, except as to capacity. They had been in service only a few years when the railroad began to replace the light 40-ton wooden coaches with steel cars of 62.5 tons weight, having only about 15 per cent greater seating capacity for 58 per cent greater car weight. At the present time these locomotives have to be double-headed 80 to 90 per cent of the time, and even at that do not have capacity to handle many of the heavier trains. With so many heavy trains in operation it is desirable to have a locomotive that can handle them without double-heading. For these reasons a new locomotive of the 2-6-2+2-6-2 type was designed, which is capable of handling all of the heavy passenger trains. Five of these locomotives were placed in service in 1919.

New Locomotives Under Construction

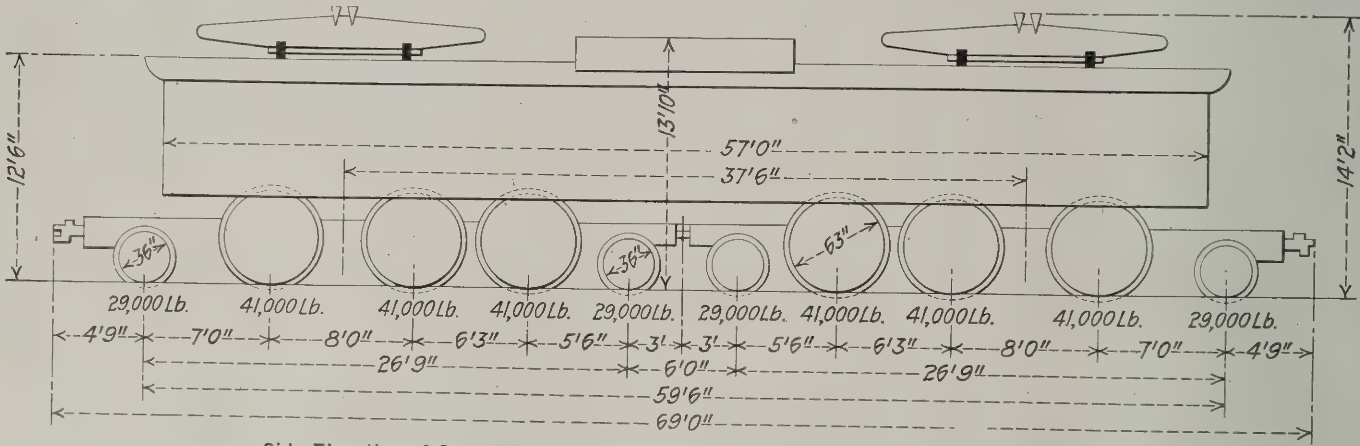
Recently 12 new 180-ton Baldwin-Westinghouse passenger locomotives were ordered and are now being built. These will be identical to the five passenger engines placed in service in 1919, except for some refinements in minor details. These locomotives are 2-6-2+2-6-2 type

equipped with six twin motors and will operate from a 11,000-volt, single-phase trolley or a 650-volt, direct-current third rail. The gear ratio will be 25 to 89 on 63-in. drivers and each locomotive will have two pantagraphs and four third-rail shoes for current collection. The weight complete will be 180 tons with 122 tons on drivers.

The motors have a combined rating of 2,016 h.p. and will develop a tractive effort of 23,200 lb. at 32.6 m.p.h. The continuous rating is 15,800 lb. tractive effort at 39.4 m. p. h. The locomotives have a high speed rating of 2,424 h. p. and develop this rating at 45.5 m. p. h. The tractive effort at this speed is 19,900 lb. A maximum momentary tractive effort of 52,500 lb. is available and the normal accelerating tractive effort is 36,200 lb. A maximum speed of 66 m.p.h. may be attained with safety.

In designing passenger locomotives for the New York, New Haven & Hartford there are always two factors which have to be given primary consideration. All passenger locomotives are limited to a maximum weight of 181 tons complete with all details including sand, water, oil and crew. This restriction is imposed on account of the Park Avenue viaduct in New York over which passenger trains run when entering the Grand Central station. The locomotives must be designed for direct-current operation from a 650-volt third rail to permit running on the tracks of the New York Central. This, of course, complicates the control apparatus.

The mechanical parts of the locomotive weigh approximately 175,000 lb. The locomotive frame is a one-piece steel casting for each half of the running gear. This means two frame castings per locomotive. They are the largest integral castings ever made for a locomotive and each casting weighs 18,000 lb.



Side Elevation of One of the New Locomotives, Showing Wheel Spacing and Loading

The quill drive and details for the new locomotives are the same as on those now in service. The drive is of the twin motor type and consists essentially of a single gear meshing with two pinions, one on each armature shaft. The frame of the motor includes two integral bearings carrying a hollow shaft or quill, which surrounds the driving axle. Sufficient clearance exists between the axle and the quill to permit the axle to accommodate itself freely to track irregularities. At the end of the

A.C. SEQUENCE OF SWITCHES

STEP	CB	1	2	3	4	5	6	7	8	9	10	11	12	M_1-M_3	M_4-M_6	M_7-M_9	M_{10}-M_{12}
	○	○												○	○	○	○
	○	○	○											○	○	○	○
	○	○	○	○										○	○	○	○
	○	○	○	○	○									○	○	○	○
	○		○	○	○	○								○	○	○	○
	○			○	○	○	○							○	○	○	○
	○				○	○	○	○						○	○	○	○
	○					○	○	○	○					○	○	○	○
	○						○	○	○	○				○	○	○	○
	○							○	○	○	○			○	○	○	○
	○								○	○	○	○		○	○	○	○
	○									○	○	○	○	○	○	○	○

D.C. SEQUENCE OF SWITCHES

STEP	L.S.	R_1	R_2	RR_2	R_3	RR_3	R_4	RR_4	R_5	RR_5	M_1-M_3	M_4-M_6	M_7-M_9	M_{10}-M_{12}
	○										○	○	○	○
	○	○									○	○	○	○
	○	○	○								○	○	○	○
	○	○	○	○							○	○	○	○
	○	○	○	○	○						○	○	○	○
	○		○	○	○	○					○	○	○	○
	○			○	○	○	○				○	○	○	○
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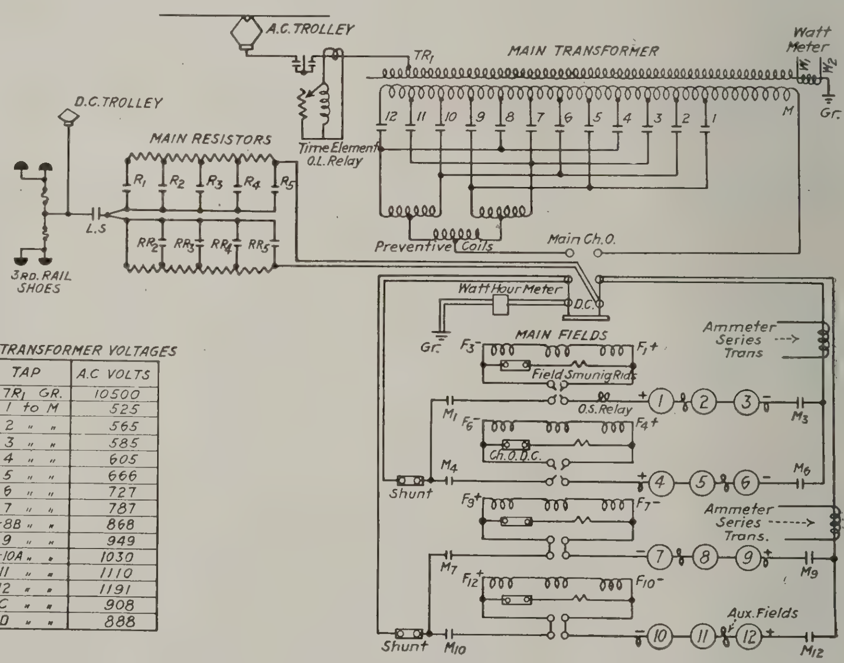
	○					○	○	○	○	○	○	○	○	○

TRANSFORMER VOLTAGES

TAP	A.C VOLTS
TR_1 GR.	10500
1 to M	525
2 " "	565
3 " "	585
4 " "	605
5 " "	666
6 " "	727
7 " "	787
8-8B " "	868
9 " "	949
10-10A " "	1030
11 " "	1110
12 " "	1191
C " "	908
D " "	888



Schematic Diagram of Main Circuits—Locomotives 0305-0316

quill a gear is mounted, meshing with the motor pinions. At each end of the quill are bolted six castings, each gripping one end of a helical spring located between the wheel spokes. The other end of each spring is gripped in a casting which is bolted to the driving wheel.

The twin motor will develop 336 h.p. at 275 volts for one hour and 276 h.p. continuously at the same voltage. The speeds at these ratings with 25; 89 gear ratio and 63-in. drivers are 32.6 m.p.h. and 39.4 m.p.h., respectively. A maximum of 357 volts may be applied to each motor armature when the trolley potential is 11,000 and the locomotive is operating on the highest speed notch of the controller. The motors are the series commutator type with a resistance lead winding in the armature, and have compensating windings.

The twin motor really consists of two complete motors with a common frame, thus making a permanent double unit. This permits an efficient utilization of the limited

Oil-Fired Flash Boiler for Train Heating

space available for motors and gearing and gives a more balanced design. A twin motor weighs approximately 13,000 lb., including bases, axle caps, axle bearings, dust guards, commutator lids, and gear cases. Each motor armature shaft has a pinion, and two pinions are in mesh with the gear for one pair of drivers, transmitting the power to the wheels through the flexible quill drive. The twin motor permits the use of a gear with a narrower face than could be used with a single motor of equal capacity since power is transmitted to the gear at two points. Consequently the gear requires less space and leaves a considerably greater length available for the active iron of the armature.

The alternating current-direct current control equipment is the unit switch, pneumatically-operated type; a duplicate of that now in service. The entire control of an engine is handled by 28 switches. This is accomplished by connecting the motors in four permanent groups of three armatures in series. The switches are arranged in three groups—motor switches, transformer switches, and resistance switches—which assists in simplifying the control.

There are three starting and nine running notches obtained by voltage taps on the transformer. The locomotives have three preventive coils, which are used when accelerating on alternating-current. Nine frames of grids are provided for direct-current acceleration. The current per locomotive during acceleration is limited and is indicated by the ammeter. The controller is "notched up" at a rate that does not permit exceeding the maximum current limit.

Series-parallel control is not provided for direct-current operation as sufficient speed can be obtained when three motors are connected in series. Series-parallel operation would complicate the control and the gain in efficiency is negligible. A field shunt, which is effective on the last controller notch gives the speed that is necessary in the direct current zone.

The airblast transformer weighs 15,300 lb., and is rated at 2,100 kilovolt-amperes. It has the necessary low tension taps for accelerating the locomotive and supplying power to the auxiliary apparatus. The storage batteries provide energy for operating the control switches and a motor-generator set charges the batteries. Motor-driven blowers are supplied to ventilate the transformer and main motors. There are two air compressors included with the air brake equipment, each having a 60 cu. ft. displacement. The blower and compressor motors are identical.

An important feature of the locomotive is the train heating equipment. Each locomotive is equipped with oil-fired flash boilers and the necessary oil and water tanks. The boiler has sufficient capacity to heat a 12-car train.

Operating Requirements

The 180-ton locomotive was selected for service on the New York, New Haven & Hartford as the best size of unit to meet all of the operating requirements. It is desired to handle all of the heavy passenger trains with a single engine, and the 180-ton locomotive has the capacity for this work. The heaviest of the express trains consist of 12 pullman cars of 75 tons each, making 900 tons' trailing load. The 180-ton locomotive is capable of hauling a train of this weight between Grand Central station and New Haven in 99 minutes on a non-stop run, which includes numerous necessary slow-downs. This is a schedule speed of over 44 m.p.h. With stops at 125th street, Stamford, South Norwalk and Bridgeport, the run can be made with the same weight of train between Grand Central station and New Haven in 115 minutes provided the aggregate of the stop time does not exceed 7 minutes. In local service, trains of 460 tons' trailing load can be handled.

The new locomotives will also be operated over the New York Connecting Railroad and Hell Gate bridge into Pennsylvania station. They are capable of hauling a 900-ton train from New Haven to Pennsylvania station in 110 minutes on a non-stop run. On one section of the west-bound Hell Gate bridge approach the grade averages 1.16 per cent for 2 miles, with a maximum of 1.22 per cent. The heaviest demand is placed on a locomotive when it is ascending the west-bound approach on this bridge.

Twelve new locomotives are being purchased at the

present time, as this number is required to provide 100 per cent electric passenger service. There has not been sufficient electric motive power to accommodate all of the passenger trains, and a number of them have not been operated with steam power, particularly those routed over Hell Gate bridge. Operating officials desire to handle all of the passenger trains with electric power to secure more efficient and reliable service as well as to keep the steam equipment out of the electric zone. After the 12 new locomotives are placed in service all passenger trains will be hauled by electric locomotives, both on the main line and on the New York Connecting.

The five 180-ton passenger locomotives that have been in service the past four years frequently make over 500 miles per day in which the longest single trip that is made is 72 miles, the distance from New York to New Haven, Conn.

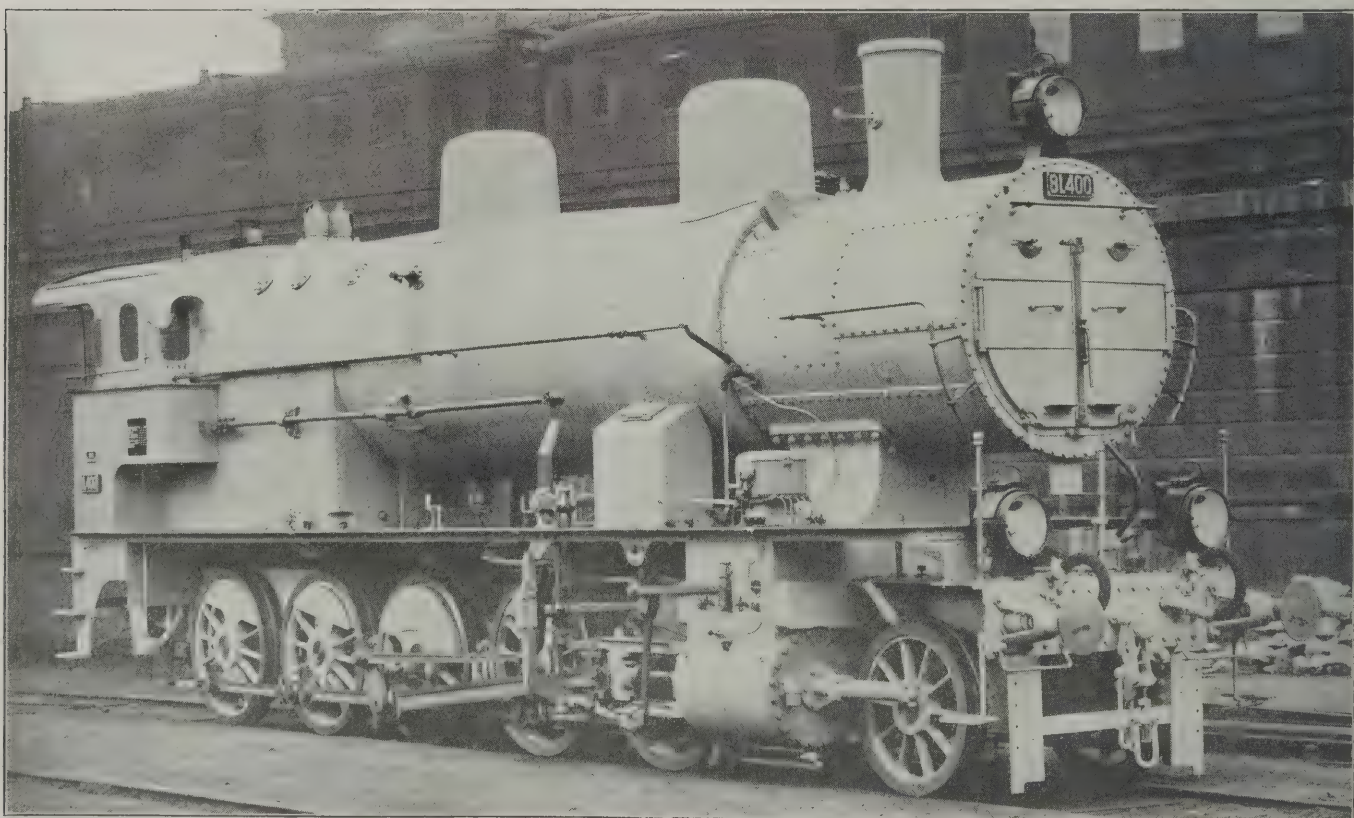
A number of the 41 original locomotives of the 2-4-4-2 gearless type have now made over 1,000,000 locomotive miles and the others are very close to this figure. They have been in service for about 16 years.

Overhead Wire Crossings

Railroad specifications for electric light, power supply and trolley lines crossing railways have been compiled and published in the Proceedings of the American Railway Engineering Association, volume 24, No. 254, dated February, 1923. These specifications have been prepared in great detail and cover the following subjects: Clearances; loading; loading on wires and cables; wires and cables; insulators; insulator pins and conductor attachments; cross arms; strength of supporting structures; wood poles; steel structures; concrete; guys; grounding; permissible unit stresses and proportions of ultimate strength; trolley line crossings; underbridge crossings; underground crossings.

The specifications as prepared represent a complete and careful revision of the railroad specifications for electric light, power supply and trolley line crossing steam and electric railways as printed in the A. R. E. A. Proceedings, volume 21, page 208. In bringing these specifications up to date, the committee that prepared them made an effort to correct inaccuracies and make the specifications conform, so far as consistent, with established railroad standards and with the requirement of Part 2 of the National Electric Safety Code prepared by the U. S. Bureau of Standards.

Because of activity of Public Service Commissions in the various states with regard to wire crossing specifications, it seemed advisable that there should be a representative of the A. R. E. A. Committee on Electricity in each state and the Board of Direction authorized under date of March 13, 1922, the appointment of such representatives with an alternate in each case. A list of these representatives and their alternates is published in the A. R. E. A. Proceedings, volume 24, No. 254, and the committee recommends that those who have transmission line crossing problems confer directly with the representatives of the Committee on Electricity assigned to that state where the crossing is in question.



New Austrian Freight Locomotive with Lentz Valve Gear

Regeneration for A-C. Series Commutator Motors*

Discussion Shows That Regeneration with Alternating Current Series Motors Can Be Properly and Satisfactorily Obtained

UNDER certain conditions a motor driving an electric locomotive or car can be converted into a generator and as such it can be used to exert a braking effect upon the vehicle either for "holding" a train while descending a grade, or for reducing the speed of the train when making a stop.

Mention is seldom made of systems of regeneration for use with single-phase series type commutator motors and probably the reader is better acquainted with the direct-current system at the present time than with any other type. Hence, in the following general discussion the writer will use the d-c. system for comparative purposes.

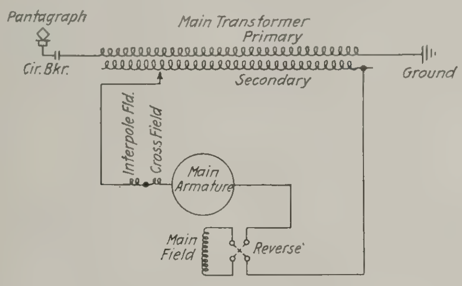


Fig. 1—Series Motor

The Westinghouse Electric & Manufacturing Company tested a regenerative single-phase locomotive on its test track for several months at East Pittsburgh as long ago as 1905, and a few years later a similar system was applied to the Midi locomotive in France.

At that time there was practically no demand whatsoever for regenerative equipments in the commercial field, and the system referred to above was used primarily in connection with a number of important gear tests which were being made at that time. The regenerative feature was utilized to give a relatively cheap and flexible load, two similar locomotives being used during the test, one regenerating while the other motored.

The a-c. series motor lends itself to regeneration in a number of important respects more readily than the corresponding direct-current series type motor. This type a-c. motor is always provided with a cross-field winding preventing armature distortion, and as it always has a relatively low impressed commutator voltage, the danger of flashing is practically eliminated.

The a-c. system also has the advantage that the existence of a transformer on the vehicle makes the variation of motor voltage very simple and economical. This, in turn, means that weakened fields at high speeds are not a necessity and that regeneration at practically all speeds down to a standstill can be accomplished with practically any desired field strength. This permits the obtaining of any desired torque with any desired speed. In general, it is possible to effect regeneration with a lower mean current in the armature and over a greater range in speed than is possible in the case of the direct-current system with its limited and less flexible voltage range; also, due to the presence of the transformer and due to the fact that connections can be completed inductively as well as conductively, the a-c. series motor lends itself more economically to a larger number of regenerative connections than appears possible with the d-c. system.

The various schemes of regenerative connections available for use with this type of motor can be divided into four distinct classes, or combinations of these classes, depending upon the type of field excitation employed. The four classes can be designated as follows:

1. Series Excitation
2. Self-excitation, or cross excitation
3. Shunt Excitation
4. Separate Excitation

The third and fourth classes have been commercially applied.

In so far as is known by the writer, no commercial applications of the first and second classes have been made as yet.

For the sake of clarity it is necessary to give in a brief manner several fundamental assumptions. In all cases it is assumed that the electrical windings are such that:

1. A motoring torque will be exerted when the field flux and armature current of a given machine have a component 180 deg. out of phase with each other.

2. A braking or regenerating torque will be exerted when the field flux and armature current have a component in phase with each other.

3. Power will be taken from the line when the armature current has a component in phase with line voltage.

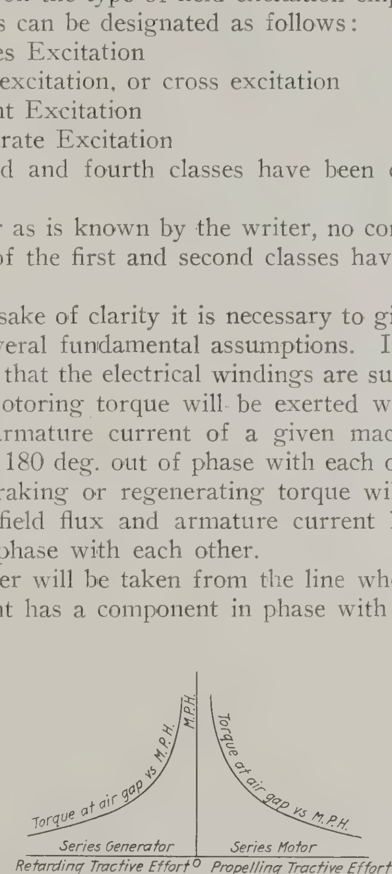


Fig. 2—Approximate "Speed-Tractive Effort" Characteristic—Series Excitation

4. Power will be returned to the line when the armature current has a component 180 deg. out of phase with the line voltage.

5. A lagging armature current will be taken from, or returned to, the line when the resultant wattless current required for the armature circuit is lagging.

6. A leading armature current will be taken from or returned to the line when the resultant wattless current required for the armature circuit is leading.

The following well-known fundamental laws will be used frequently and are stated in order that the reader may more easily follow the writer's various presentations:

(1) The sum of the voltages in any closed circuit must be equal to zero, that is, the sum of all the counter

*Abstracted from a paper presented by L. I. Hibbard before the Mid-winter convention of the American Institute of Electrical Engineers, New York City, February, 1923.

voltages must be equal and opposite to the impressed voltage.

(2) When a voltage is applied to a reactance, the current produced will lag 90 deg. behind the impressed voltage. The reactive drop, or counter voltage, produced by this current must be 180 deg. away from the impressed voltage in order to produce a balanced condition, and hence the reactive drop must lag 90 deg. behind the current that produces it.

(3) Likewise, when a voltage is applied to a resistance, the current produced will be in phase with the impressed voltage. The *R I* drop, or counter volts, produced by this current must be 180 deg. away from the impressed voltage in order to produce balance, and hence, it is 180 deg. away from the current.

(4) The counter electromotive force set up, due to a rotating conductor cutting a given flux, will be in phase with the flux cut.

Motoring with Series Excitation

In line with the above the operation of the series motor as a motor assumes the form shown in Fig. 1 which is a schematic of a typical main circuit connection.

The transformer voltage applied across the motor terminals sets up a circulating current in the motor circuit. The motor circuit is inductive and therefore the current lags the impressed voltage. The circulating current thus set up produces a counter voltage equal and opposite to the impressed voltage. At standstill this counter voltage is composed entirely of the impedance drop around the armature circuit. The impedance drop consists of a resistance and reactance drop. The reactance drop is at right angles to the resistance drop. The resistance drop is 180 deg. away from the armature current and in phase with the field current.

As the speed of the motor increases a counter electromotive force is set up across the armature which adds directly to the resistance drop in the circuit. Hence at any speed except zero the resultant counter voltage is

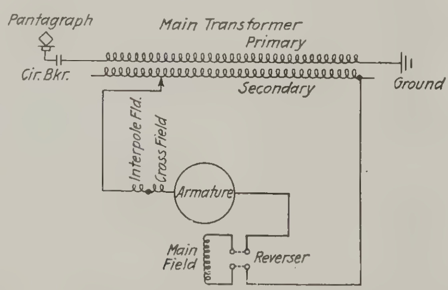


Fig. 3—Series Generator

composed of the counter electromotive force as well as the impedance drop in the armature circuit. As this counter electromotive force grows in value with any given constant impressed voltage the impedance drop and hence the armature current must decrease in value to maintain the proper resultant value of counter-voltage. Hence, with a fixed terminal voltage the armature current and consequently the propelling torque, decreases as the speed increases.

Fig. 2 shows the typical shape of the speed torque characteristic obtained with the series connection.

Regeneration with Series Excitation

In order to regenerate after motoring with the series connection the main field must be reversed. Thus Fig. 3 shows a typical main circuit schematic for this connection. The operation regenerating is similar to the operation motoring except that the field current, and consequently the field flux and resultant torque produced, has been reversed. Thus at standstill the counter voltages set up are exactly the same as in the motoring connections at standstill. However, as the speed increases from standstill the counter electromotive force set up is in the opposite direction and hence opposes the resistance drop but remains at right angles to the reactance drop. Thus at some definite speed where the counter electromotive force is just equal and opposite to the *R I* drop the armature current will lag the line voltage by exactly 90

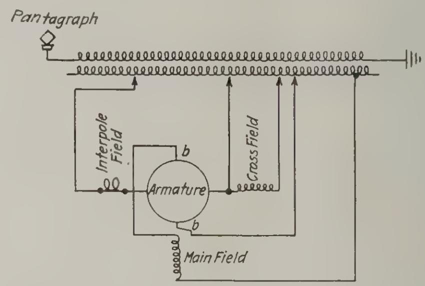


Fig. 4—Cross Field of Self Exciting Generator

deg. since the only counter voltage available is the reactance drop around the armature circuit.

At this point the generator is supplying its own losses and hence is drawing no power from the line. As the speed increases above this value the counter electromotive force overbalances the resistance drop and the resultant counter voltage is equal to the vector sum of the reactance drop and the difference between the resistance drop and counter electromotive force and the resultant vector relations are such that power is returned to the line. This can be readily seen if the difference between the counter electromotive force and the resistance drop is considered as a negative resistance drop. The presence of a positive resistance drop indicates the use of power and hence the presence of a negative resistance drop must represent the generation of power.

Thus it is seen that the alternating-current series motor can be made to operate as a series generator merely by reversing the fields. A suddenly decreased line voltage will not increase the regenerated current of the line frequency as in the case of direct current, but will tend to decrease it. Similarly an increased speed with any given impressed voltage will also decrease the regenerated current. While these characteristics would make its use for regeneration possible, other difficulties have to be overcome for a practical solution along these lines.

The system is handicapped by the strong tendency of the generator to pick up as a direct-current generator with the secondary transformer winding serving practically as a short circuit. Even if direct currents are made impossible, as in the case of a repulsion motor, there is a strong tendency for low-frequency currents to be set up, causing trouble. Also the speed torque characteristics obtained with this connection (See Fig. 5) are not the best type for all classes of regenerative service since the torque tends to decrease as the speed increases for any given value of impressed voltage. In view of these difficulties this method of regeneration has so far not been seriously considered for railway applica-

tion in this country. Undoubtedly, however, due to its simplicity it has possibilities for the future.

Regeneration with Cross-Field or Self-Excitation

A regenerative system of the second kind with the main motors acting as armature (self-excited) generators is shown in Fig. 4. In this system the armature is supplied with an extra set of brushes *b b* which are located around the commutator midway between the normal or motoring set. The cross field is connected across a section of the main transformer. The resultant current and flux set up in the cross field circuit is approximately 90 deg. behind the line voltage since the field circuit is highly inductive. The armature conductors revolving in and cutting the cross-field flux set up by a counter electromotive force across brushes *b b* in phase with the flux cut and hence at right angles and lagging the line voltage.

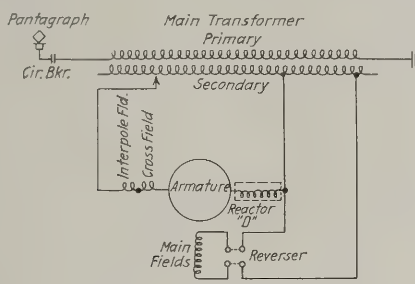


Fig. 5—Shunt Generator

This voltage is then connected across the main field and sets up a current and flux through the main field approximately 90 deg. behind voltage *b b* or approximately 180 deg. away from the line voltage. The armature conductors revolving in and cutting this main field flux set up a voltage across the normal brushes approximately 180 deg. away from the line voltage. Hence, when these terminals are connected to the transformer the resultant voltage difference will set up a circulating current in the circuit. If the line voltage impressed is greater than generated voltage a motoring torque will be produced and power will be drawn from the line. If the generated voltage exceeds the line voltage a braking torque will be exerted and power will be returned to the line. The small section of transformer voltage in the excitation circuit is introduced in order to neutralize the resistance drops in both the cross field and main field circuits and hence maintain the regenerated voltage exactly 180 deg. behind the line voltage.

This system is handicapped due to the fact that the armatures, and also the commutators of the main motors, have to be increased in capacity because they carry the exciting currents in addition to the load currents. This is quite a serious handicap in view of the space limitations existing for the main motors in connection with railway work. Another disadvantage of the system is the necessity of additional brushes around the commutator.

However, such a system is advantageous in so far as it gives a shunt or flat speed-torque characteristic, and as it permits of power factor compensation during regeneration, and possibly during motoring, within certain limits. Hence, it eliminates the necessity of auxiliary rotating apparatus that otherwise might be required to obtain this power factor compensation feature and therefore probably has certain possibilities for the future.

Regeneration with Shunt Excitation

The simplest form for a shunt type regenerative system is shown in Fig. 5. The main fields are connected directly across a section of the main transformer. The resulting field current and flux set up in the circuit lags approximately 90 deg. behind the line voltage. The armature conductors revolving in and cutting the field flux set up a counter electromotive force across the armature circuit in phase with the flux cut and hence approximately 90 deg. behind the line voltage.

The armature is thus connected in series with an external reactor and across a section of the main transformer. The vector sum of the counter electromotive force generated in the armature and the voltage impressed across the armature give a resultant voltage in the armature circuit which lags behind the line voltage by some angle depending upon the relative values of the impressed and generated voltages: This resultant voltage sets up a circulating current in the armature circuit which lags by approximately 90 deg. since the armature is highly inductive due to the external reactor. Hence, since the field current and flux are also lagging the line voltage the armature current has a component in phase, the field flux, and is therefore exerting a braking torque. Also, due to the fact that the resultant voltage in the armature circuit lags the line voltage and to the fact that the armature current is approximately 90 deg. behind this voltage, the armature current must lag the line voltage by more than 90 deg. hence will have a component 180 deg. away from it. Thus, power will be returned to the line.

If the main fields are reversed in the above connections, the counter electromotive force produced will be reversed. This will shift the resultant voltage in the armature circuit by 90 deg. and likewise the armature current.

The resultant voltage will lead the line voltage while the armature current will lag the line votage, by something less than 90 deg. depending upon the relative values of the line voltage and the counter electromotive force.

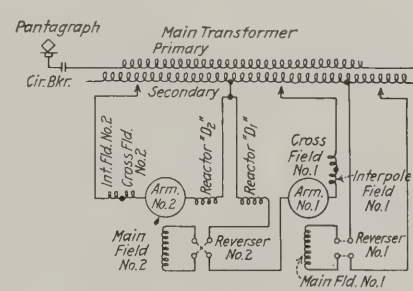


Fig. 6—Regeneration—Modified Shunt—Excitation

Hence a motoring torque will be produced and power will be drawn from the line.

The chief handicap of this system lies in the fact that it does not permit of power factor correction during the regenerating period and must always draw a resultant wattless component of current from the line for excitation. It is also handicapped to some extent due to the fact that the same continuous torque between the armature and field windings, possible with the series connection, cannot be obtained in the shunt connection due to the phase difference between the armature current and field flux inherent with this connection. However, in practical applications sufficient torque can be developed between the

windings such that when added to the losses the resultant retarding effort available will be more than sufficient for holding any train while descending a given grade that can be hauled up the same grade with the series connection. Also, when the obtainable torque is not sufficient for any given application the speed-torque characteristics can be adjusted easily and properly for parallel operation with the airbrakes on the train. Hence, this connection will provide ample tractive efforts for a large majority of the future commercial applications.

The connections and control are simple and reliable. Practically only two units are added to the normal motoring control apparatus, these units consisting of a simple substantial reactor and a simple change-over switch for controlling the reactor. The speed torque characteristics available cover practically the entire range from (1) a vertical curve, that is constant torque at all speeds (see Fig. 13A), which is ideal for straight deceleration purposes, to (2) a shunt or relatively flat curve, that is increasing torque with increasing speed (see Fig. 13c), which is the desirable characteristic for use in holding a train at some given desired speed when descending a grade.

Hence, this form lends itself readily to practically any class of service and will undoubtedly be in great demand for future commercial applications.

A modified form of the shunt connection is shown in Fig. 6.

Separate Excitations

The regenerative systems utilizing separate exciters during the regenerating period can be divided into two general classes as follows:

1. Constant Speed Exciter Systems
   (a) Phase Converters
   (b) Motor Generator Sets.
2. Variable Speed Exciters
   (a) Separate Axle Generators
   (b) Main Motor as an Exciter.

In the following a description will be given of a constant speed exciter system using a phase converter as an exciter. A variable speed exciter system using one of the main motors as an exciter will be described in appendix E.

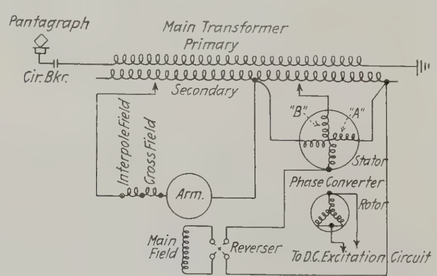


Fig. 7—Regeneration—Constant Speed Exciter System

A constant speed exciter system is shown in Figs. 7 and 8. In this system the phase converter or exciter is essentially a two-phase synchronous or induction motor running on single phase. Hence, a voltage is generated across the second or open phase at right angles to the line voltage impressed across the motoring phase. In most applications of this type a two phase synchronous motor will probably be employed in order that it may be operated as a synchronous condenser during the motoring period for power factor correction. Also, with the use of the direct-current excitation in the rotor the main motor field excitation can be supplied in part if not entirely without drawing it all in the form of wattless lagging current from the line.

The right angle voltage obtained from the generating phase of the phase converter is connected in series with the main field of the traction motor and across a section of the main transformer. The vector sum of these two voltages gives a resultant voltage which sets up a field current and field flux through the field circuit. The resultant field voltage lags the line voltage by some angle depending upon the relative values of transformer voltage and phase converter voltage employed. The resultant field current and field flux lag behind this voltage by 90 deg. since the field circuit is highly inductive, and in consequence thereof lags behind the line voltage by more than 90 deg.

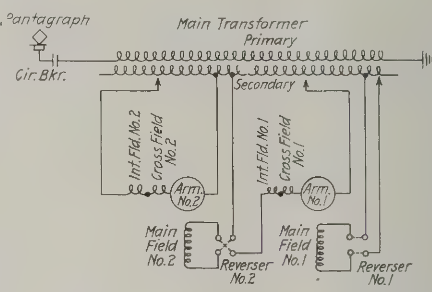


Fig. 8—Regeneration—Variable Speed Exciter System

The main armature conductors revolving in and cutting this flux set up a counter electromotive force across the armature in phase with the flux cut. The vector sum of this counter electromotive force and of the transformer voltage impressed across the armature gives a resultant voltage which sets up circulating current in the armature circuit. The armature current lags the resultant armature voltage by some angle depending upon the relative values of the resistance and reactance drops through the circuit.

By the proper manipulation of the transformer voltages impressed across the main field and armature circuits (and when desired, the phase converter) the circulating armature current can be given a leading or lagging component 180 degrees away from the line voltage, and at the same time exert a braking torque, or it can be given a leading or lagging component in phase with the line voltage, and at the same time exert a motoring torque. Thus all requirements for regeneration can be fulfilled.

Conclusion

In general, it can be safely stated that probably any future regenerative application that may be desired, can be properly and successfully taken care of with one or more of the various single-phase systems available at the present time.

As a whole the systems are so flexible that the selection of a particular system for any given application can probably be governed in the main by the requirements of the particular application only, and can be chosen to best suit the requirements of that application.

Basic Principles for the Electrical Workman

A Series of Articles Explaining Clearly the Reasons Underlying the Operation of Simple Circuits and Apparatus

By K. C. Graham

Part 4 — Generators, Motors and Storage Batteries

WHEN a wire is moved across the pole of a magnet it cuts the lines of force and a voltage is induced or generated in the wire. The direction in which this voltage causes a current to flow, if the circuit is complete, is easily remembered by referring to Fig. 43.

Here we see that conductor *A*, moving downward as

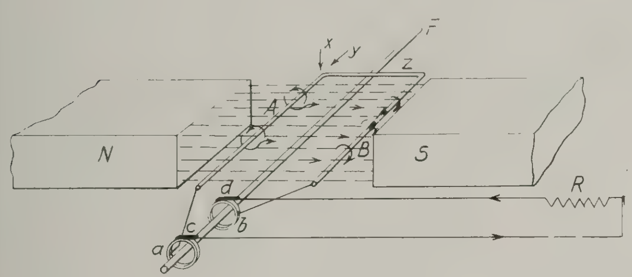


Fig. 43

shown by arrow *X*, has a voltage generated in it which tends to cause a current to flow in the direction indicated by arrow *Y*. Now the lines of force flow from *N* to *S* and when conductor *A* moves downward at *N* it causes the lines to bend in such a way that they point downward to the left of *A* and upward to the right of *A*, which is the same as the lines, caused by the current in *A*.

A voltage tending to send current in the opposite direction is induced in *B* and if the two wires, *A* and *B*,

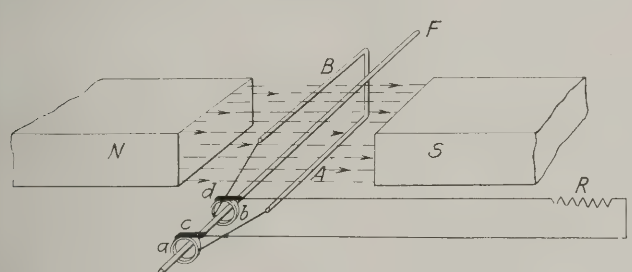


Fig. 44

are joined together at the rear by wire *Z*, and at the front to the collector rings *a* and *b*, brushes *c* and *d*, which press against *a* and *b*, will establish a circuit through the resistance *R*, and current flows in the direction shown by the arrows.

As the coil turns on shaft *F* it reaches the position shown in Fig. 44 where it is moving parallel with the lines from *N* to *S*. In this position it is not cutting any lines and consequently no voltage is generated in it.

Now, as the coil continues to rotate, *A* starts to cut across *S* and *B* to cut across *N*, Fig. 45, thus causing the current in the external current *R* to be opposite in direction from what it was in Fig. 43.

Thus with each half revolution of the coil, the current through *R* reverses or alternates in direction and is called an *alternating current*.

Suppose resistance *R* happens to be a storage battery or other device which requires *direct current* (a current that always flows in the same direction). Now if we attach the ends of our coil to a split ring, Fig. 46, the current will be flowing in the direction shown, for this position of the coil and brush *a* will be resting on segment *x* of the split ring and brush *b* on segment *y*.

As the coil continues to rotate it will reach the position shown in Fig. 47. In this position no current is generated in the coil and brushes *a* and *b* are each resting partially on each of the segments *x* and *y*.

As rotation continues the coil reaches the position

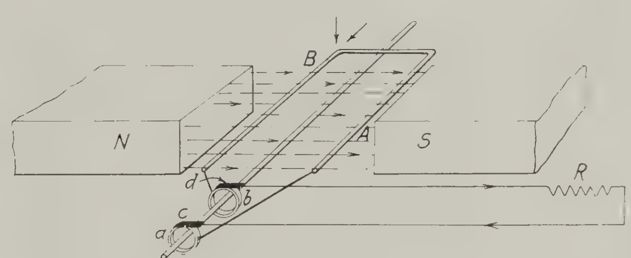


Fig. 45

shown in Fig. 48 at which time brush *a* is resting on segment *y* and brush *b* on segment *x*.

It will be noted that current flows through *R* in the same direction for either position of the coil. In this case the current is direct current.

The *split ring* is an elementary form of commutator; large armatures being merely a large collection of coils and the commutators being collections of split rings. We shall not study armature windings in detail, at this point, as they are not of immediate interest to us.

If we reverse the direction of the armature, we see,

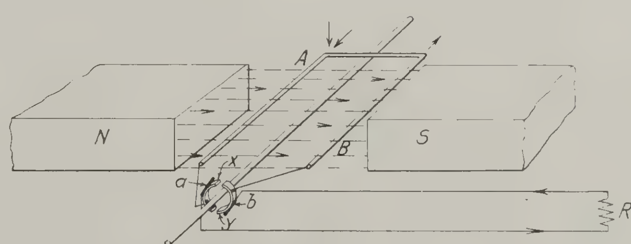


Fig. 46

(Fig. 49) that the direction of the current through *R* is reversed.

Now, if we interchange brushes *a* and *b*—that is, place brushes *b* on *x* and brush *a* on *y*, Fig. 50, the current will be the same for the new direction of motion of the coil as it was for the former direction of motion, Figs. 46 and 48.

Fig. 50 illustrates very clearly the principle of the pole-changer, which is used on nearly all modern car-lighting

systems—its function being to keep the direction of the current in the same or external circuit regardless of direction of motion of the car.

Fig. 51 shows wire *A* in a magnetic field between pole pieces *N* and *S*. Now, if the current flows downward (into the paper) the magnetic whirls around the wire will be in the direction shown, that is, clockwise. The lines of force from *N* to *S* pass in the same direction above the wire as to the whirls, while below the wire the lines from *N* to *S* are opposite in direction to the magnetic whirls. This causes the lines to crowd, above the wire while below the wire the lines are thinned out because the lines forming the magnetic whirls, oppose or neutralize some of those from *N*. Since lines of force

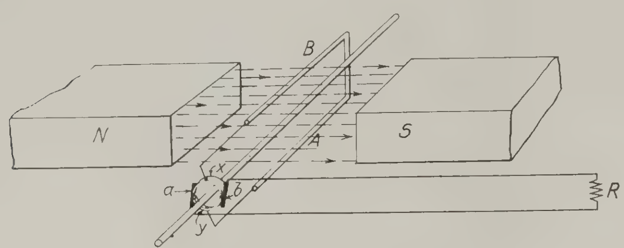


Fig. 47

are elastic, like rubber bands, they tend to straighten themselves and in so doing force wire *A* downward as in Fig. 51.

In Fig. 52, *D* is a dynamo supplying current to conductor *A B* which is in the magnetic field *N S*. Due to the action explained in Fig. 51, the conductor rotates. Thus, Fig. 52 illustrates the fundamental principles of the electric motor.

In Figs. 46 and 48 current enters the resistance *R* from brush *a* and returns to the dynamo through brush *b*. Brush *a* is called the positive (+) brush of the dynamo and brush *b* the negative (—) brush. In Fig. 52 current flows from the positive brush *b* of dynamo *D*

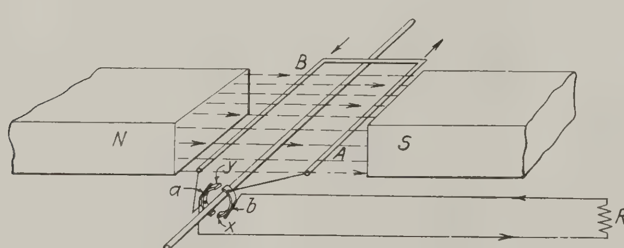


Fig. 48

to positive brush *b* of the motor, that is, current *enters* the positive brush of the motor.

Thus it is seen that the positive side of a generating device (dynamo or battery) is that side from which current enters the external circuit, while the positive side of a consuming device (lamp, battery, meter, etc.) is that side at which current enters the device *from* the circuit.

One important fact to be noted at this point is that the voltage (number of volts) or pressure generated in a dynamo depends on the strength (number of lines per square inch) of the field and the speed of rotation (revolutions per minute) of the armature. If the strength of the field remains constant while the speed increases, then the voltage increases; if the speed remains constant while the field strength increases the voltage increases; if the field strength remains constant while the speed decreases the voltage decreases, and if the speed remains constant while the field strength decreases the voltage decreases.

Figs. 44 to 53 show the field composed of permanent magnets, but in practice the only machines with permanent magnets are magnetos, all others use field coils which are really electro magnetic solenoids, the coil (solenoid) being called the field coil, while the core is called

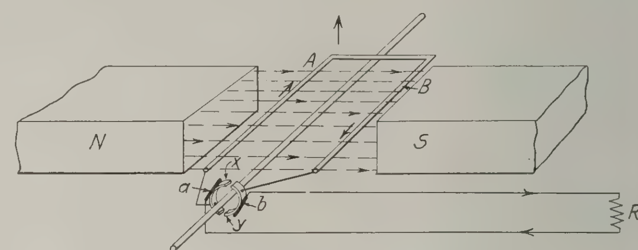


Fig. 49

the pole. With this type of field, the field strength (which depends on the ampere-turns) may be varied at will; whereas if the field were made up of permanent magnets its strength would remain constant (the same) at all times.

When current through the coils has ceased, the poles

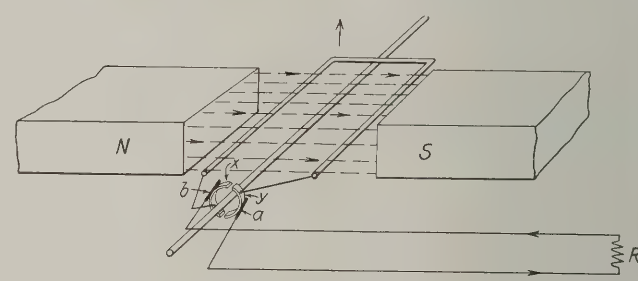


Fig. 50

retain a little of their magnetism. This magnetism which remains is called *residual* magnetism—residual, meaning to remain.

Storage Batteries

Although the lead battery enjoyed a monopoly of the car-lighting field for a number of years, the Edison

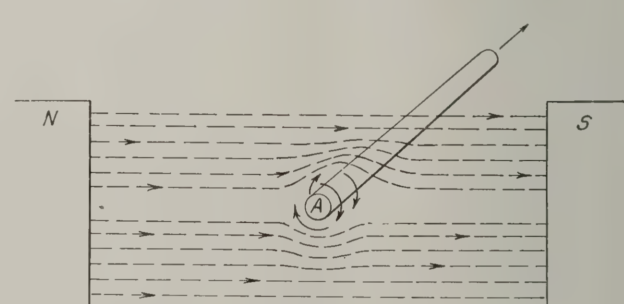


Fig. 51

nickel-iron battery is making large inroads into the field at the present time.

In the lead battery, Fig. 53, the electrolyte, as it is called, is a solution of sulphuric acid. The positive plate is lead peroxide and the negative, pure lead when the battery is in a state of charge. When the battery is discharged the active surface of both plates become lead sulphate.

It must be understood that a storage battery does not store electricity but the electricity in passing through it brings about a chemical change thereby converting the two like plates, which are lead sulphate, into two unlike plates, one of which is lead peroxide and the other pure lead. There is no difference in potential between two lead sulphate plates, therefore no current will flow when the plates are in this condition, but there is a difference in potential between lead peroxide and lead, and a current will flow if these two plates are connected by a conductor.

When on discharge, the storage battery is nothing more or less than an ordinary primary cell and acts as such until the surface of both plates has again been converted into lead sulphate.

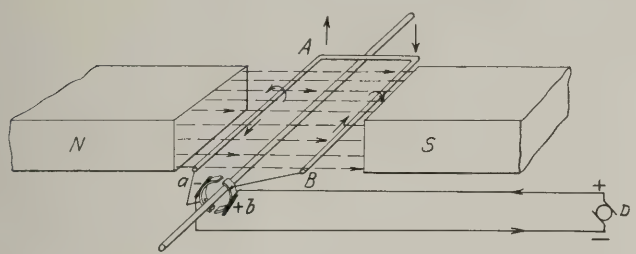


Fig. 52

The Edison cell, Fig. 54, is similar to the lead cell. The solution is caustic potash instead of sulphuric acid and the positive plate is nickel peroxide while the negative plate is iron. We shall not study the Edison cell in detail, at this point, but shall take it up later on.

The capacity of a battery to deliver current is measured in *ampere-hours.*

An ampere-hour is one ampere flowing for one hour or one-half ampere for two hours, that is, ampere-hours equal amperes times hours.

Now, lead batteries are based on an eight-hour rate, that is, they are designed to deliver current continuously for eight hours at a rate which depends on the capacity of the battery. For instance, a battery rated at 320 ampere-hours will give a continuous current of 40 amperes for a period of eight hours.

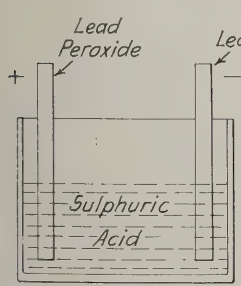


Fig. 53

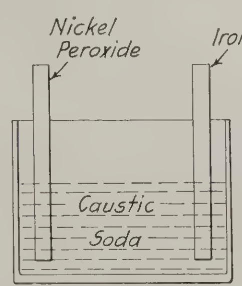


Fig. 54

When the battery is recharged it should (theoretically) be charged for eight hours at a rate of 40 amperes. This does not actually hold good in practice because we never get as much out of a battery as we put into it, due to the fact that there is some loss in forcing current into the battery and in taking current out, in other words, the efficiency of the battery is not 100 per cent; in fact no device exists the efficiency of which is 100 per cent. Therefore, in practice we must charge the battery for a period somewhat longer than eight hours at a rate of 40 amperes.

A good indication of the state of charge of a lead cell may be obtained by taking a specific gravity reading. This is taken by means of an instrument called a *hydrometer,* which is simply a weighted glass float which has a graduated scale to show how far it sinks into the liquid. The distance it sinks depends on the density (specific gravity) of the liquid. The specific gravity of water is 1.00 while that of the electrolyte varies, depending on the state of charge of the battery, being about 1.225 when the battery is charged. Now, as the battery becomes discharged the sulphate from the acid enters the plates, thus making the electrolyte thinner and thinner, its density approaching that of water until in extreme cases, it actually becomes water.

If the hydrometer sinks no lower than the 1.225 or 1.200 mark, it shows the battery to be fully charged, but if it sinks to the 1.100 mark it shows the battery to be pretty well discharged. Any reading in between these readings shows an intermediate state of charge. The hydrometer reading is of no use in connection with the Edison cell, so far as showing the state of charge, but is only applicable to lead cells.

Fig. 55

The voltage between + and — plates of a lead cell varies from 2.5 volts when fully charged, to 1.8 volts when discharged. The cell should never be discharged below 1.8 volts because it injures the plates to discharge it until the voltage falls below this point.

It must be borne in mind that no matter how large or how small the plates of a cell, the voltage is never more than 2.5 volts. The size of the cell only governs its ampere-hour capacity.

Fig. 55 shows dynamo *D* supplying storage battery *SB* with current. It will be noted that + terminal of the dynamo is connected to + terminal of the battery and that current flows from + to — through the battery. In Fig. 56 current flows from the + battery terminal to the + light terminal and from the — terminal to the + terminal through the battery. This is due to the fact that in the first instance, the battery is a consuming device while, in the second instance, the battery is a generating device.

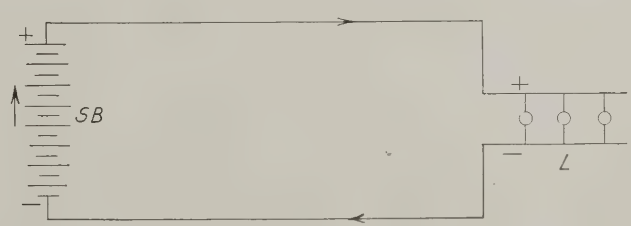


Fig. 56

Automatic Train Control Developments

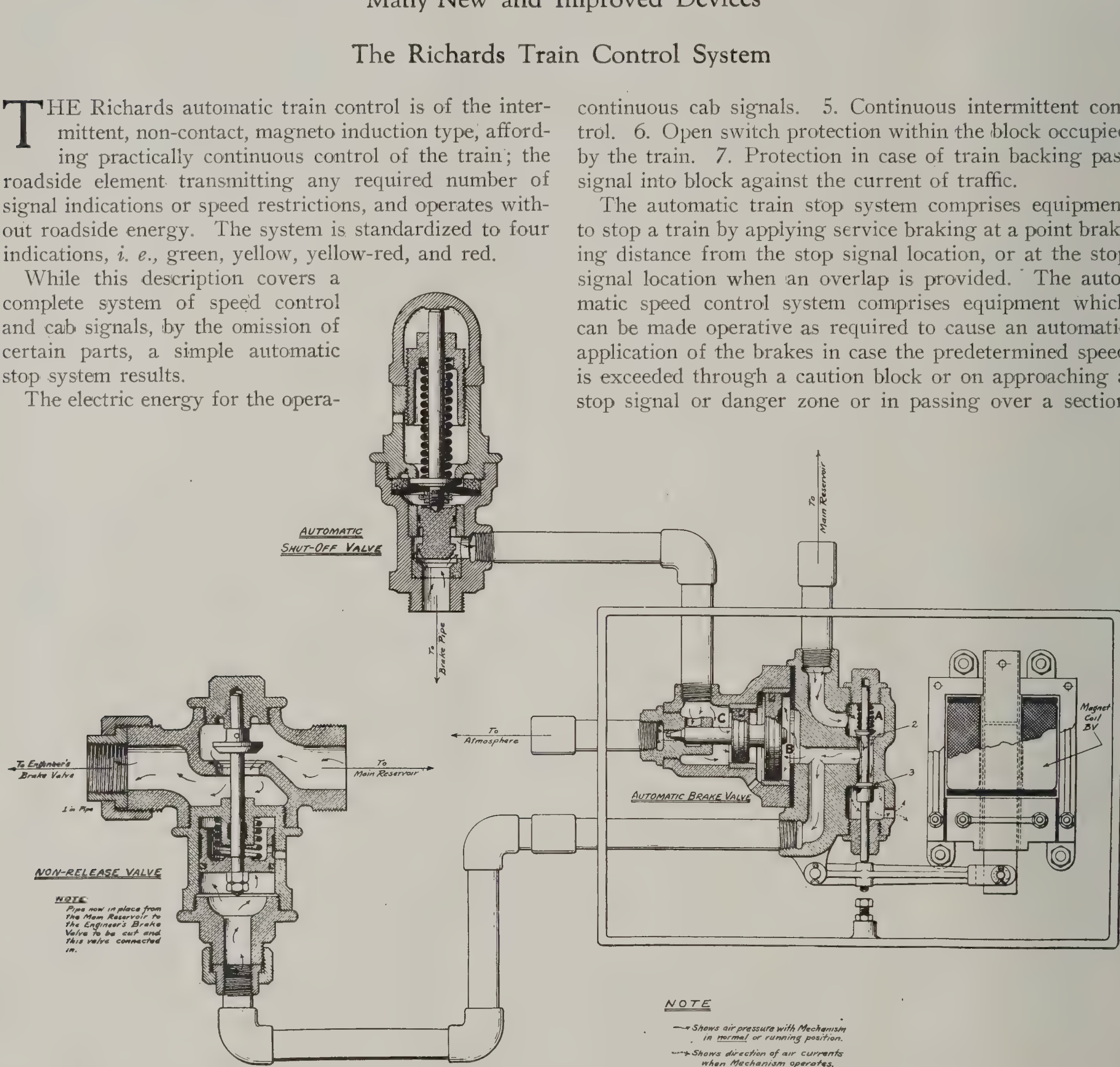
Increasing Activities Are Manifested By the Appearance of Many New and Improved Devices

The Richards Train Control System

THE Richards automatic train control is of the intermittent, non-contact, magneto induction type, affording practically continuous control of the train; the roadside element transmitting any required number of signal indications or speed restrictions, and operates without roadside energy. The system is standardized to four indications, *i. e.,* green, yellow, yellow-red, and red.

While this description covers a complete system of speed control and cab signals, by the omission of certain parts, a simple automatic stop system results.

The electric energy for the operation of the entire device, track and locomotive apparatus, is received from a small a. c. generator on the locomotive, which assures the proper inductive relation between the track and the locomotive apparatus, regardless of the speed. By the use of an alternating current auxiliary attachment, which has been developed by the Pyle-National Company expressly for the Richards system, the automatic train control may be operated by current from the existing head-light turbo-generator.



Cross-section of Automatic Brake Valves on the Locomotive

The Richards system comprises equipment which can be combined as required to give the following control: 1. Plain automatic train stop. 2. Plain automatic train stop with continuous cab signal indications. 3. Automatic speed control. 4. Automatic speed control with continuous cab signals. 5. Continuous intermittent control. 6. Open switch protection within the block occupied by the train. 7. Protection in case of train backing past signal into block against the current of traffic.

The automatic train stop system comprises equipment to stop a train by applying service braking at a point braking distance from the stop signal location, or at the stop signal location when an overlap is provided. The automatic speed control system comprises equipment which can be made operative as required to cause an automatic application of the brakes in case the predetermined speed is exceeded through a caution block or on approaching a stop signal or danger zone or in passing over a section of track where it is desired to enforce a speed restriction.

The automatic train stop system may be expanded into the complete speed control and cab signal system when subsequent traffic conditions warrant, as both systems have the same foundation, in principle and apparatus. The device can be installed to operate in connection with any existing signal system with a very slight addition to existing circuits. No power line wires or other external source of power is required.

Roadway Equipment

The track apparatus is located outside the running rails at each signal location and consists of two primary track coils *TP* and *TP′* connected in series, and a secondary

track coil TR, wound on a three-pole laminated structure of soft iron. The coils are connected in series through the contact points of relays designated as M and N, the contacts of relay N controlling the direction of the induced current in the track coil TR. Relay M is controlled by the track circuit, and the opening of its contacts opens the circuit between the track coils TP and TR when the track is occupied.

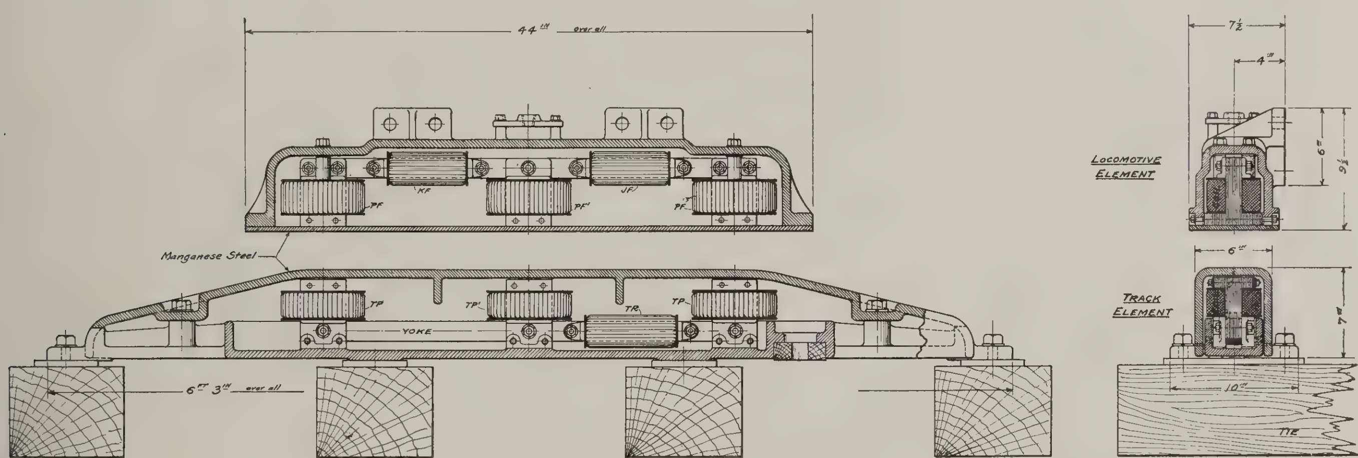
The purpose of the track coils designated as TP and TP' is to receive an induced current as the locomotive passes over them from the coils designated as PF and PF' on the locomotive. The current thus induced is conducted through the contact points of relays M and N to the track coil TR which produces a magnetic flux in the coil TR, which, in turn, increases or decreases the flux in a secondary coil JF carried on the locomotive.

Engine Equipment

The locomotive apparatus consists of a receiving element comprised of coils designated as PF, PF', JF and KF for forward motion, and a similar set of coils PB, PB', JB and KB for backward motion, each set being wound on a three-pole laminated structure of soft iron, and arranged so as to co-operate with the track coils in accordance with the direction of motion. A reversing switch is provided to reverse the circuits when the engine is running backward.

This equipment is supplemented by green, yellow and red cab signals, three relays, K, J and R, a closed core transformer T, a release key or push button, a governor or speed circuit breaker, an automatic brake valve, and also an a. c. generator to supply current to the engine and track apparatus. A plug receptacle is provided for connecting with current in the roundhouse to pick up cab relay R, as explained later.

The automatic brake valve consists of an electro-magnet normally energized by current from the a. c. generator through the contact points of relays R and J, and when energized closes a port 3 to atmosphere and opens a port 2 against spring tension, permitting air to flow from the main reservoir to a second chamber B having a differential piston with a valve stem and seat in a third chamber C with an opening to atmosphere. The main reservoir pressure in chamber B holds the differential piston valve to its seat and prevents the escape of train line pressure to atmosphere. Chamber B of this valve is connected by pipe to a non-releasing valve having a piston and a stem so arranged that when main reservoir pressure forces the piston upward it raises a valve from its seat against spring tension and opens a port in the upper chamber of the non-releasing valve, permitting the main reservoir pressure to flow direct to the engineer's brake valve. When the brake valve magnet BV is de-energized the valve 2 seats, shutting off the main reservoir pressure from chamber B and from under the non-releasing valve piston; at the same time the port 3 to atmosphere is opened, allowing the air pressure in chamber B and from under the non-releasing valve piston to escape to atmosphere. Brake pipe pressure in chamber C then forces the differential piston to a position which opens a port and permits the brake pipe pressure to exhaust to atmosphere. When the air pressure is exhausted from under the piston in the non-releasing valve a spring causes this piston to move downward, closing a port between the main reservoir and the engineer's brake valve, thereby preventing the release of the brakes until the mechanism is restored to normal position. To prevent the brake pipe pressure from being reduced below a predetermined point an automatic shut-off valve is connected in between the brake pipe or train line and chamber C of the automatic brake valve, and comprises a port held open against spring tension by the brake pipe air pressure. When the pressure in the brake pipe is reduced sufficiently to permit the spring to close this port, no more air is permitted to exhaust through chamber C.



Locomotive and Track Elements for Transmission of Control

Operation of Circuits to Pick Up Indication

The engine coils PF and PF' are continuously energized from the a. c. generator and their magnetic flux continuously energizes the secondary windings designated as engine coils JF and KF. The current thus induced in the coil JF energizes a relay J, in a stick circuit through the armature and contact of the relay. The current induced in the coil KF energizes a relay K in the same manner. If the current transmitted to track coil TR is in a direction to produce a flux in a direction corresponding with the flux of the engine coil JF, the flux in coil JF will be greatly increased, causing an increase of current through relay J so that the relay will not be opened. If the direction of the current in track coil TR is reversed, the flux of the coil TR will be in a direction to oppose that of engine coil JF, causing the flux of these coils to be greatly

reduced, and the current supplied by engine coil *JF* will not be sufficient to hold up relay *J*, which will, therefore, be de-energized. The armature and contact of relay *J* shunts the resistance *R2* when closed, the opening of the contact causing the resistance *R2* to be included in the relay holding circuit, causing the relay to remain open after the engine coils have passed off the track coils, due to the increased resistance in the circuit. If the coil *TR* is located in the track element in position to affect engine coil *KF*, then the cab relay *K* will be operated in a manner similar to that of the cab relay *J*.

A closed core transformer designated as *T* has its primary winding *A* continuously energized from the a. c. generator, in a circuit when running forward, from the generator through a fuse and the primary winding *A*, through the engine coils designated as *PF* and *PF'*, and through a contact on the reverse switch back to the generator. A secondary *B* of transformer *T* energizes the holding circuit of a relay *R*, through a stick circuit from one side of secondary *B*, through a fuse and the armature and contact of relay *R*, through the relay coils to the other side of the secondary. When the engine coils *PF* and *PF'* are over the track coils *TP* and *TP'*, the coils *TP* and *TP'* act as the secondary of a transformer and the engine coils as the primary of the transformer.

If the circuit between the track coils is closed current will be drawn from the engine coils *PF* and *PF'*, causing an increase of current to flow in the primary circuit, which includes the primary winding *A* of transformer *T*, and a correspondng increase of current in the secondary *B* which energizes relay *R*. Should the circuit between the track coils be open, no current will be drawn from the engine coils and the soft iron core of the track coils forms a path of low reluctance for the flux of engine coils *PF* and *PF'*, and the increase of flux in these coils increases their reactance, thereby causing a considerable drop in current in primary *A* of transformer *T*, and a corresponding drop in secondary *B* sufficient to de-energize relay *R*. The armature and contact of relay *R* shunts the resistance *R3* when closed, the opening of the contact causing the resistance *R3* to be included in the relay holding circuit, so that relay *R* will remain open after the engine coils have passed off the track coils.

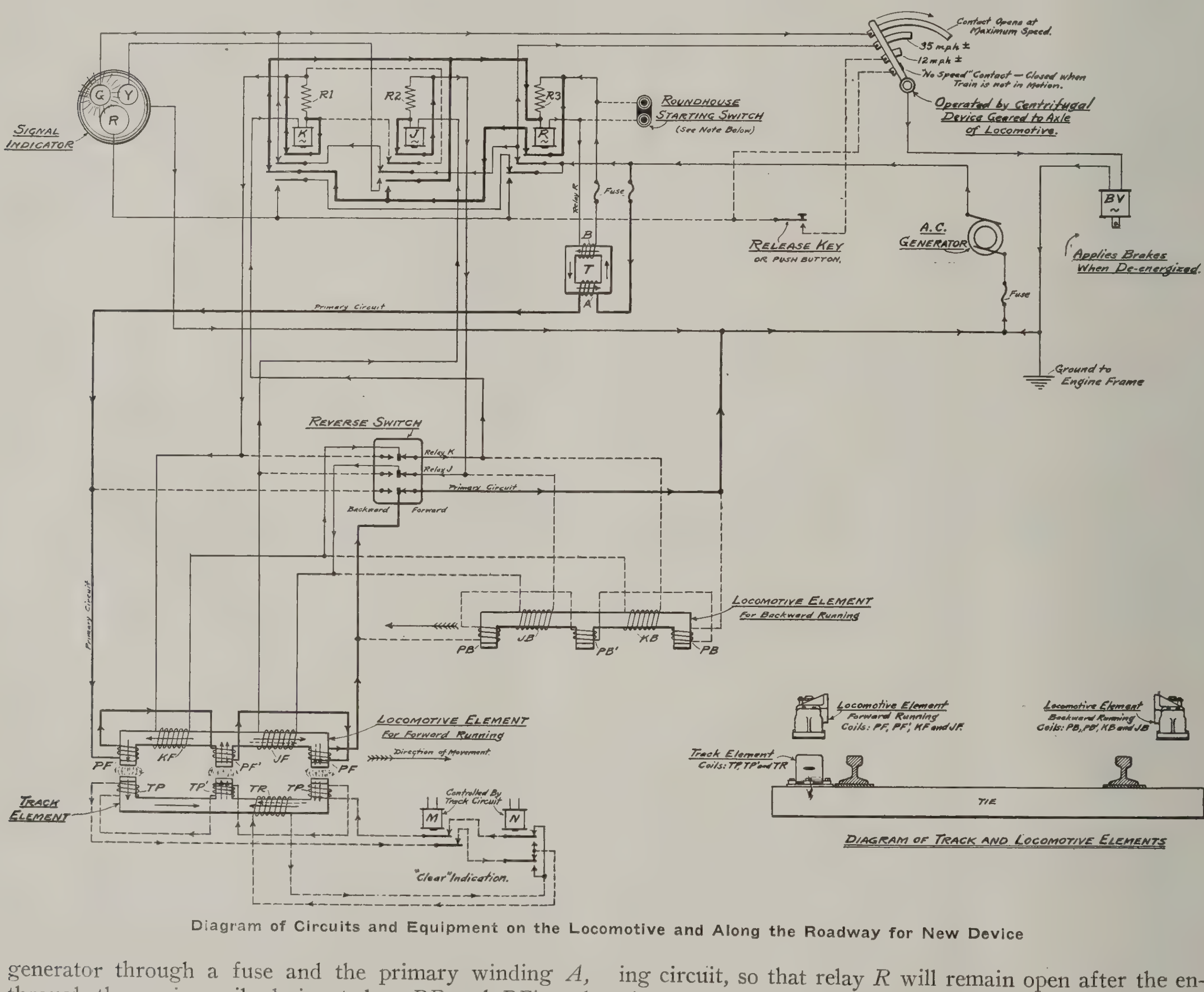
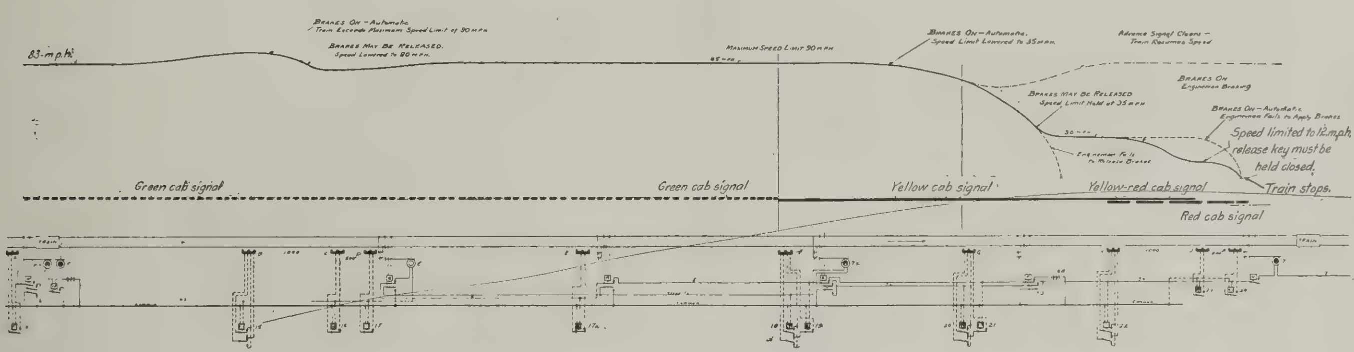


Diagram of Circuits and Equipment on the Locomotive and Along the Roadway for New Device

Current is supplied by the a. c. generator through a front contact on relay *R*, a front contact on relay *J* and a front contact on relay *K* to the green cab signal, and a branch of this circuit through the governor contact springs energizes the brake valve magnet *BV*, so that when the speed of the train exceeds the prescribed maximum rate the governor contact springs will open, de-energizing the brake valve magnet. When relay *J* is de-energized current is supplied through a back contact to the yellow cab signal. Current is supplied through a front contact on relay *R*, through the governor contact

springs which open at the prescribed medium rate, to energize the brake valve magnet BV. When relay K or relay R is de-energized, current is supplied through a back contact to the red cab signal, to a release key and a governor contact spring so arranged that in order to pass a stop signal it is necessary to have the train speed below twelve miles per hour, or some predetermined low rate, and to hold the release key closed so as to maintain the circuit direct to the brake valve magnet BV. When relay R is energized the resistance $R3$ is shunted by a front contact on relay R in series with a front contact on relay K, and a back contact on relay J is arranged to bridge the front contact on relay K when relay J is energized. Should relay K be opened while relay J is energized the shunt around resistance $R3$ will be opened, causing the resistance $R3$ to be in series with the coils of relay R, and, due to increased resistance in the relay holding circuit, relay R will remain de-energized. Thus the opening of relay K will cause relay R to open also, but should relay J be de-energized the back contact on relay J will be closed, and when relay K opens relay R will not be affected.

The reverse switch consists of a ball bearing having the inner ball race mounted tight on a shaft of the locomotive, and provided with a contact piece which is pressed against a stop or contact point to complete a circuit according to the direction of rotation of the shaft. Friction rings are provided to increase the friction between the inner and outer ball race to give the required pressure at the contact points.



Typical Speed and Braking Curves with Road Side and Signal Circuits

Four Signal Indications

The system is standardized to four inductions, *i. e.*, green, yellow, yellow and red, and red. The operation of the device with the locomotive running forward is as follows:

The GREEN or "clear" cab signal. Track relays M and N are energized and when the locomotive passes over the track coils, the energized engine coils PF and PF' induce a current in track coils TP and TP' which flows through the contact points of relays M and N to the secondary track coil TR, causing a magnetic flux to be induced in track coil TR in a direction indicated by the arrow. At this instant the magnetic flux furnished to coil JF is in a direction indicated by the arrow, and in the same direction as the flux of track coil TR, so that the flux of coil JF will be increased, sending an increased current through the coils of relay J, so that the relay will not be opened. The circuit being closed between the track coils, the current in the circuit including the engine coils PF and PF' and the primary A of transformer T will be increased, so that relay R will also receive an increase of current. Relay J, being held energized, its front contact shunts the resistance $R1$ so that relay K will be held energized. All relays being energized the circuit is maintained through the green cab signal and the train can proceed at maximum speed.

The YELLOW or "caution" cab signal. Track relay M is energized but relay N is de-energized. As the engine passes over the track coils current is induced from the engine coils to the track coils as previously described, the back contacts of relay N being closed the direction of the current from track coils TP and TP' to the track coil TR is reversed, causing the flux of coil TR to be in a reverse direction to that received at a clear signal. As the flux of coil TR will oppose that of coil JF, the current supplied to relay J is greatly reduced, thus causing relay J to open.

Due to the circuit between the track coils being closed, relay R will receive an increase of current and will, therefore, not be opened. When relay J is thus de-energized the circuit through the green light is opened and the circuit through the yellow light established. The resistance $R2$ now being in the holding circuit, relay J will remain open after the engine passes off the track coils. Should the speed of the train be above the prescribed rate when relay J is de-energized, the governor contact springs will open the circuit to the brake valve magnet BV, causing an application of the brakes.

The YELLOW AND RED or "approach" cab signal. When the red cab light is illuminated with the yellow it indicates that the train is approaching the stop signal location where the release key must be held closed and the train run at low speed. As far as possible this indication is always given a uniform distance from the stop signal location.

Track relay M is energized and relay N de-energized, and current is induced from the engine coils to the track coils as previously described. At this location the coil TR is arranged in the track element in position to affect the engine coil KF, so that relay K will be opened by the flux in the coil TR opposing the flux of engine coil KF, in the same manner as relay J is operated at a caution signal.

Relay J, having been previously de-energized at a caution signal location, the circuit to the yellow cab light is complete, and the opening of relay K, through its back contact, establishes the circuit to the red cab light, so that both lights are displayed at the same time. Should the train pass this track element without having previously received a caution signal, relay J will be energized at the

time relay K is opened, and the opening of the front contact on relay K will cause relay R to open, giving a red or "stop" signal instead of a yellow-red indication, and an automatic application of the brakes will result. The circuit between the track coils being closed, relay R will not be opened if relay J has been previously de-energized at a caution signal. While the yellow-red indication is displayed an automatic brake application will result if the prescribed medium rate of speed is exceeded while in this block.

The RED or STOP cab signal. The track relay M is de-energized, thereby opening the circuit to the track coils and flux is induced in coil TR to affect engine coils JF and KF. The windings of track coils TP and TP' being open, the iron core and yoke form a path of low reluctance and causes the flux in engine coils PF and PF' to be increased, this causing increased reactance in these coils and a considerable drop in the current in the primary A of transformer T, and a sufficient drop in secondary B to open relay R. The opening of relay R opens the circuits to relays J and K, and through a back contact on relay R the circuit to the red cab signal is complete.

When the front contact of the relay R is open the relay coils are then in series with the resistance R_3, so that relay R will remain open, due to increased resistance added to the circuit, after the engine coils have passed off the track coils. Through the back contact on relay R current is supplied to the brake valve magnet BV as long as the speed does not exceed the prescribed low rate and the release key is held closed by the engineman. When the train is not in motion the circuit to the brake valve magnet is maintained direct through the governor contact springs without the release key being closed. In order to pass a stop signal, it is necessary to hold the release key pressed to establish a circuit from the back contact on relay R through the brake valve magnet BV, and the train can then proceed at a predetermined low speed through the block. Exceeding this speed causes the governor contact springs to automatically open the brake valve circuit, resulting in an application of the brakes.

Roundhouse Starting Switch

A plug receptacle is provided, designated as the roundhouse starting switch, whereby a connection can be made with current in the roundhouse momentarily to pick up relay R after the engine generator has been started. This energizes the brake valve magnet BV, and permits the engine to leave the roundhouse with a caution cab signal. This plug and receptacle is so designed that it cannot be plugged to pick up relay R when the engine is away from the roundhouse, compelling the operation of the release key should a red signal be passed on the roadway.

One side of the a. c. generator is grounded to the engine frame and the primary and secondary circuits of transformer T include a fuse to protect against grounds and crosses. Should the wires between the track coils TP and TP' and TR become crossed, the coils TP and TP' would be the equivalent of a short-circuited secondary of a transformer and a great amount of current would be drawn from the primary coils PF and PF', causing the fuse in the circuit to blow and relays R, J and K to be opened, resulting in an application of the brakes.

The Schweyer Induction Train Control

The Schweyer automatic train control system is of the intermittent non-contact, inert roadside element type. Recent developments of the system have eliminated the track battery and "reflex induction" is now used for this purpose.

New developments in the circuit and apparatus have brought out the so-called "super capacity circuit." When running normal, where there is no unusual amount of steel along the track, the current is about 1.28 amp. When the coil comes over an extra rail, such as at a switch turnout, the current falls to 0.85 amp., but when the coil passes over the inert armature located on the ties, the amperage falls to a value of 0.39 amp., causing the relay to open. With former circuits an extra rail caused higher current in the coil, whereas the new circuit now causes a reduced current, eliminating any chance of false clear operations.

Explanation of Wiring Diagram

All the track apparatus as shown on the wiring plan is located between the running rails. The coil in the middle of the track is connected selectively in series with the coil at its left, or the coil at its right, depending upon the position of the track relay or other suitable switching device.

The middle track coil receives an induced current as the inducing coil of the locomotive passes over it and this induced current is conducted, under clear or caution conditions, either to the track coil at its right or to the track coil at its left. If the signal is at danger these coils at the right, or the left, are disconnected from the middle coil by any suitable switch or relay controlled by the track circuit. The track coils are wound on a laminated core. Adjacent to these coils are track armatures for the purpose of increasing the choking effect of the transformer coils on the engine, which are in series with the control or actuating relay.

The locomotive apparatus consists of an inducing coil suspended from the middle of the engine, being magnetically linked with two transformer coils in series with the control relay. This control relay controls two holding relays so that each time it passes a signal the stick circuits of the holding relays are broken. Two receiving coils, one at the right and one at the left hand side of the inducing coil, pick up energy from the track under the clear or the caution conditions, so as to cause a relay, in series with each, to hold up selectively or energize the external circuit of the clear or caution holding relays. As shown, the clear or caution holding relay controls an electro-pneumatic valve, as well as a visual or audible indication. An a. c. generator 50 supplies current continuously to the engine induction coil 3. Transformer coils 29 and 30 being magnetically linked with the induction coil 3, are energized and hold up relay 18, excepting when passing over the track armatures 33 and 34, at which time the choking effect causes the relay to release its armature. Caution holding relay 9 is a stick relay and when in the raised position it is energized by the generator 50, the circuit being from connection 1, winding of relay 9, con-

tact 5, contact of control relay 18, back to generator. Clearing holding relay 10 is energized by the circuit from connection 1, winding of relay 10, contact 8 and contact of control relay 18, back to the opposite connection of the generator. Pickup relay 17 is in series with the receiving coil 28 via connections 25 and 26, so that when the receiving coil 28 is energized, pickup relay 17 raises its armature and loops around the stick circuit of holding relay 19 via connection 4, relay 9, connection 1, back to the opposite side of the generator. Similarly, pickup relay 19 is in series with receiving coil 27, through connections 23 and 24, so that when receiving coil 27 is energized, relay 19 picks up its armature and loops around the stick

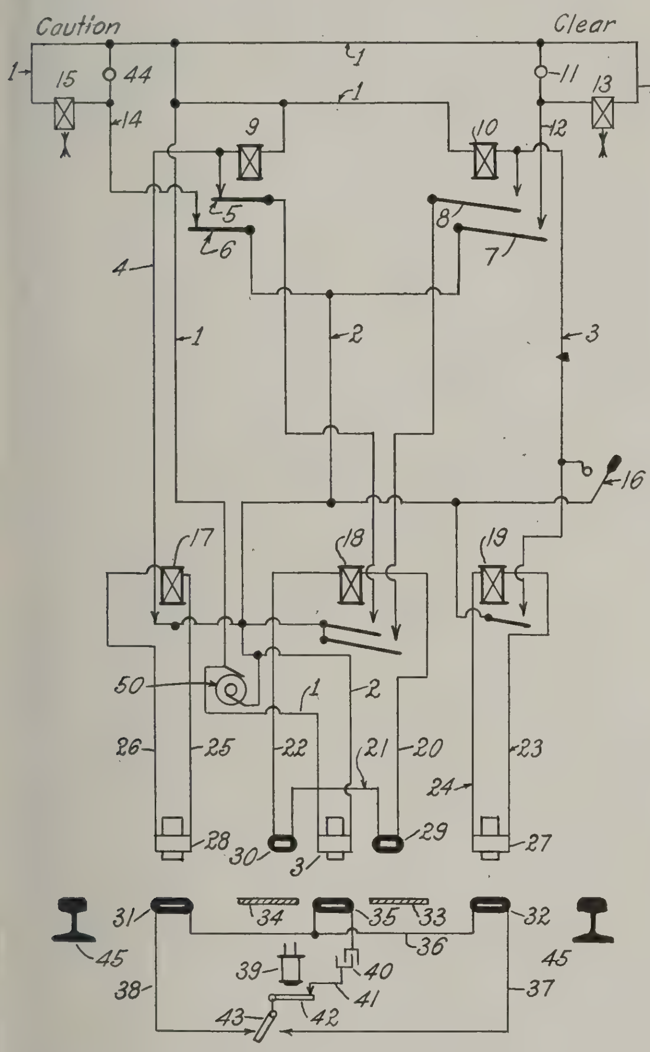


Diagram of Connections of the Relays, Inductors and Magnets

circuit of holding relay 10, by way of connection 3, relay 10, circuit 1, back to the opposite connection of the generator 50. When the clear relay 10 raises its lower contact 7, it simultaneously energizes electro-pneumatic valve 13 and indicator 11 via circuit 2, contact 7, connection 12, through indicator 11, and eletctro-pneumatic valve 14, and circuit 1 back to the opposite connection of the generator. Similarly, when caution holding relay 9 raises its lower contact, the electro-pneumatic valve 15 and indicator 44 are energized via circuit 2, 5, connection 14, indicator 44 and electro-pneumatic valve 15, and circuit 1, back to the opposite connection of the generator. The operation of the apparatus is explained below:

When Passing a Clear Signal

In starting the engineman closes the clearing switch 16, causing energy from the alternator to pick up the clear holding relay 10, thus energizing the clear electro-pneumatic valve 13 and the visual or audible indication 11, which is in parallel. This action allows the train to proceed, because the contacts of the control relay 18 are in a raised position, due to the induced flux from the inducing coil 3, which energizes the transformer coils 29 and 30 in series with the control relay 18.

When the train passes the track elements in the clear position, the middle track coil 35 is connected in series with the transmitting coil 32, through the armature of track relay 39. The choking effect caused by the track armature 33-34 causes the armature of control relay 18 to open on account of the increased reactance in coils 29 and 30, which would stop the train were it not for the fact that, simultaneously with this action, the engine inducing coil 3 induces a current in the middle track coil 35, which is now connected in series with transmitting coil 32 via condenser 40, armatures 42 and 43. The transmitting coil 32 being energized induces a current in the receiving coil 37 in series with pickup relay 19. Pickup relay 19 raises its armature connecting the external circuit of holding relay 10, which in turn energized the clear electro-pneumatic valve 13 and the visual or audible indicator 11, allowing the train to proceed under full control of the engineman.

Passing a Caution Signal

On the drawing the connections are shown to cover the conditions when the train passes the track elements in the caution position. The armature 43 is to the left. The choking effect caused by the track armature 33-34 causes the armatures of control relay 18 to open, due to the increased reactance in coils 28 and 30, which would stop the train were it not for the fact that simultaneously with this action the inducing coil 3 on the engine induces a current in the middle track coil 35, which is now connected in series through the condenser 40, contacts 42 and 43, with transmitting coil 31. Transmitting coil 31 being energized, a current is induced in receiving coil 28, which is in series with pickup relay 17. Pickup relay 17 closes its contacts which connect the external circuit of holding relay 9; this relay turn then energizes the caution electro-pneumatic valve 15 and the visual or audible indication 44, allowing the train to proceed at restricted speed.

Approaching Stop Signal

As the locomotive passes over the track elements in a stop position the track armatures 33 and 34 open the control relay 18, which causes the train to stop, because transmitting coils 31 and 32 are not connected to track coil 35.

If the locomotive turns around and runs back over these coils in the opposite direction it is necessary only to throw a reversing switch, which will connect pickup relay 19 to receiving coil 28 and pickup relay 17 to receiving coil 27. The track armatures 33 and 34 may be placed at the side of the rail instead of between the rails or the choking action of the track armatures may operate in advance of the pickup flux action instead of simultaneously as shown in the drawing.

Simple Device Locates Electric Circuit Troubles

A simple, but ingenious, device for testing signal circuits has been devised by Jesse Debrick, assistant foreman of signals at Baltimore on the Pennsylvania. The device itself consists only of a pair of iron rods connected to a telephone receiver. The rods are about the length of an ordinary walking stick, are pointed at one end and are bent into the form of a handle at the other. One of the two terminals of the telephone receiver is connected to each of the iron rods.

Jesse Debrick Testing for Signal Circuit Trouble

The process of locating trouble with the device consists simply of thrusting the pointed ends of the rods into the ground and listening with the telephone receiver. When a short circuit is reported on a given circuit, a pulsating direct current or an alternating current is impressed on the grounded wire. The other terminal of the power supply is connected to ground, thus making a complete circuit. The operator walks alongside, or over the trunking which carries the grounded wire and pushes the iron rods into the ground at points approximately a yard apart alongside of the trunking. One of the rods should, of course, be closer than the other to the point at which the current used for testing is impressed on the wire as the function of the device is to detect the presence of the return circuit in the earth. If the rods are on the feed side of the ground, a noise is heard in the receiver. The iron rods are then moved one at a time along the wire until the sound ceases. This indicates that the trouble has been passed as the rods have been moved out of the return ground circuit. An open circuit may be located in a similar manner, as there is a condenser action between the earth and the wire which sets up a flow of current through the receiver sufficient to make an audible sound. The device was made for testing signal circuits, but, of course, has a wider application and can be used also for locating trouble on telephone or power circuits.

Measuring Outside Diameter Without Calipers

Having recently to measure the outside diameter of a pipe in a power house where calipers were not instantly available a quick and reasonably accurate method was devised.

Two nuts were tied to the ends of a piece of string and one of them thrown over the pipe. When they stopped swinging, it was a simple matter to measure the distance between the cords, which was the outside diameter of the pipe close enough for any ordinary purposes. This can be used on a shaft when not practical to measure in the ordinary way.

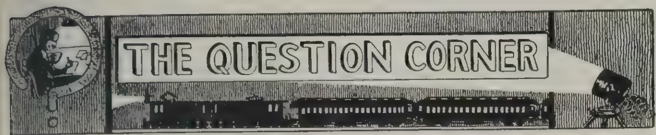
Twelve Things to Remember

1. The value of time.
2. The success of perseverance.
3. The pleasure of working.
4. The dignity of simplicity.
5. The worth of character.
6. The power of kindness.
7. The influence of example.
8. The obligation of duty.
9. The virtue of patience.
10. The wisdom of economy.
11. The joy of originating.
12. The profit of experience.

Let us have faith that right makes might; and in that faith let us dare to do our duty as we understand it.

If dissatisfaction and grievances can be eliminated, and co-operation substituted, think how much it will lighten your work; think how much it will increase efficiency and production.

The wages of idleness is demotion.



Answers to Questions

1. What do you think is the probability that some form of direct drive for car lighting generators will supersede the commonly used belt drive within the next few years?—A. O.

2. What is the best method for using a voltmeter to measure voltages outside the range of its scale?—M. M.

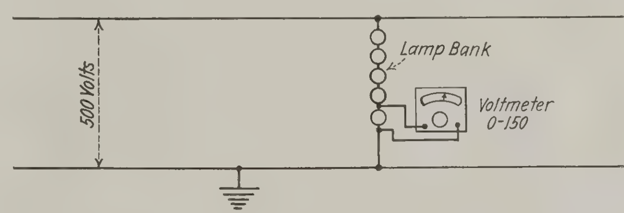
The Probability of Direct Drive

1. The probability of general adoption of direct drive for car lighting generators in the near future is extremely doubtful. A number of car lighting equipment companies have been doing some experimental work along these lines for some time and some forms of drive have actually been developed which appear to give good results as far as operation is concerned. However, the great trouble has been and will continue to be the excessive first cost of such installations. There is no question but that the loss of belts is expensive, not to say exasperating, but we are bound to admit that expensive though this practice may be, it is still cheaper than any direct drive that has been thus far produced, when all of the factors are considered and of course, under such conditions direct drive has little chance. If some form of mechanical drive should appear which proves desirable and cheap in first cost, then it will be a different story. Thus far nothing has seemed to meet all requirements. The direct drives which have been tried experimentally have been too few in number to draw any definite conclusions and even among these, the ones which have been most successful are much too high in price. There is another factor which must be considered in the substitution of mechanical drive for belts and that is the matter of maintenance. Not only does the mechanical drive have to compete with the belt in the matter of first cost but to obtain any standing whatever its design must be such that it can easily and quickly be maintained. Any mechanical drive which makes it necessary to shop a car in order to care for minor troubles would obviously be looked upon with disfavor. When some form of mechanical drive appears which requires very little maintenance and is both reliable and low in price, we can begin to look for some substitution for the belt. Such a development certainly would not seem to be beyond the realms of possibility but at present, too few have been tried out and these not for sufficient length of time to say that the day of the car lighting belt is about over.

Measuring Voltage Outside the Range of the Voltmeter

2. Measuring voltage of higher values than the scale of the voltmeter is intended for, can be accomplished in several ways. One type of voltmeter which is very common has a scale reading of from 0 to 150. Such an instrument can be used with entire success on much higher voltages when connected in series with a fixed resistance of known value. The resistance of this type is called a multiplier and its resistance is made so that it can be used in conjunction with one particular voltmeter. The scale of the voltmeter when used with the multiplier, of course, assumes different values. For example, by using the proper multiplier a voltmeter with a scale of 0 to 150 volts can be made to read from 0 to 1,500. A multiplier can be designed for any change which may be desired in the regular voltmeter scale. There is, however, one requirement which must always be fulfilled and that is that it must always be used with the same voltmeter, otherwise the readings will not be accurate. Moreover, it becomes impracticable to use multipliers for very high voltages as it would be cheaper to purchase instruments adopted for this kind of work. Furthermore, multipliers are laboratory instruments and rarely used in outside measurements to any great extent.

One method which can be easily and successfully used in measuring voltages in excess of the scale range is that of taking the drop across the individual lamps of a lamp bank, as shown in the illustration. In this case, five lamps



Method of Measuring Voltage Outside the Range of Voltmeter

are connected in a series across a circuit of 500 volts. It must, of course, be known approximately what the voltage of the circuit is, otherwise the lamps might be burned out immediately upon connecting them to the circuit. It is, therefore, necessary to use a sufficient number of lamps in series to prevent a flow of current which will burn them out. After such a lamp bank is connected, it is a simple matter to read the voltage drop across each lamp in turn. The voltage across the two mains then will be the sum of the drops across the several lamps.

Questions for April

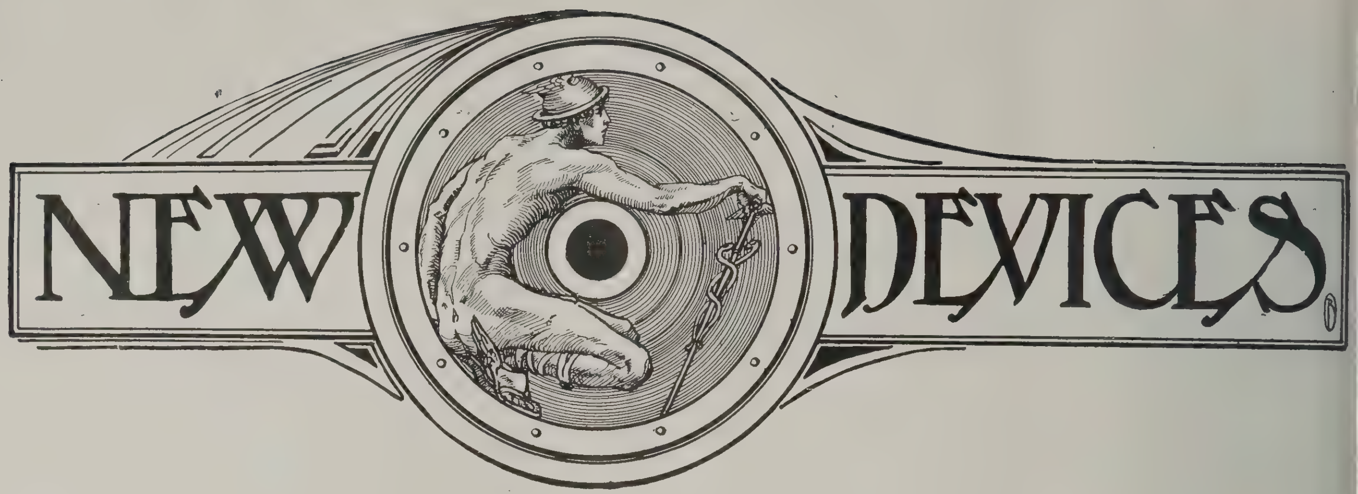
1.—*I have several different makes of batteries of the same voltage and ampere-hour rating, some of these are lead and some Edison. I would like to operate same in parallel. What would be the result? Let us hear from some of the car lighting men.—E. I.*

2.—*In referring to the* RAILWAY ELECTRICAL ENGINEER, *March number, Question Corner, Page* 90. *What is the d. c. voltage after current goes through the lamp bank and four jar electrolytic rectifier?*

3.—*Could more than one battery be charged at one time?*

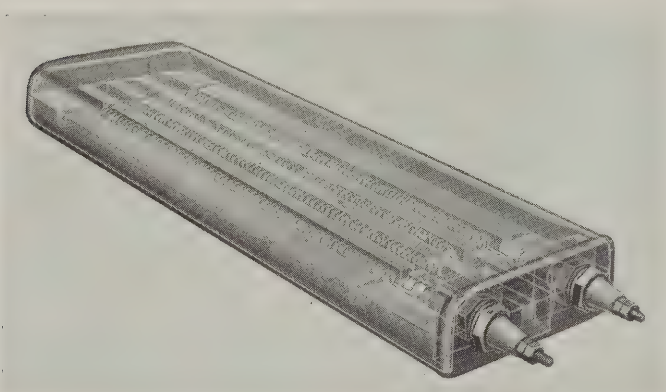
4.—*Could the ampere charging rate be measured by an ammeter placed in one side of the line after leaving the jars?*

5.—*Where can I obtain a good book on ignition work on automobiles and also a practical electrician's handbook dealing in motors, compensators, starters, relay coils and in fact all connections?*



Electric Snow Melter

One of the troubles with which a large number of the railroads have to contend is that of keeping switches in yards and terminals open during the time when snow and sleet are falling. In busy localities this requires a constant force of men during these periods. Even under ordinary circumstances the cost of this work is by no means inconsiderable and during times of labor shortage



Phantom View of a Heater Unit

it not only becomes more expensive, but it becomes a serious problem since labor is not always available. This condition has led to the development of various types of snow melting devices, some automatic, and some manually controlled or operated.

The electric snow melter falls more nearly in the first class, since after the device is installed it is only necessary to turn on the current, after which the installation continues to function until the snowfall has stopped. In this respect these devices become large labor savers. On one of the eastern railroads where electric snow melters are in regular use, the work of 25 to 35 men has been eliminated. Some of the results obtained by electric snow melters appeared on page 267 of the September, 1918, issue of the *Railway Electrical Engineer.*

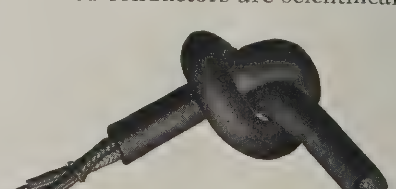
Important changes have been made in the design of the unit since that time, the new device being more efficient. Formerly heat was obtained by means of resistance coils wound on porcelain tubes supported by asbestos blocks and surrounded by an asbestos gasket which was copper covered. This left a large air space around the heating elements. In the new type this air space has been eliminated, the construction simplified and greater effectiveness secured. The heaters measure 18 in. long, 6½ in. wide, and 2 in. thick and are enclosed in a seamless, drawn brass container. The wiring is connected to two spark plug type terminals. The heating units are coiled resistance wire laid in small channels cut in one of two halves of a soap stone block made of a size to fit the container with only 1-32 in. clearance. When assembled, current is turned on the units and they are kept under working temperature until all possible moisture contained in the unit is driven off through two small holes drilled in the case, after which the case is hermetically sealed.

Each unit consumes one kilowatt of electricity per hour and operates on either alternating or direct current. They are made in two voltage sizes, namely 47 and 55 v. in order that varied combinations can be made for different classes of input current. Fourteen heaters are installed in one 15 ft. to 16 ft. turnout. A temperature of 600 deg. F. is maintained and this is obtained in 45 min. The heaters remain hot for about 6 hours after the current is turned off, thus keeping open the natural drainage in the ballast as well as thoroughly drying out the switchpoint and preventing the accumulation of ice due to the after freezing of the melted snow.

Unbraided Portable Cord

Okocord is the name of a new, flexible, unbraided portable cord recently placed on the market by the Okonite Company, Passaic, N. J.

The double-tinned conductors are scientifically stranded,



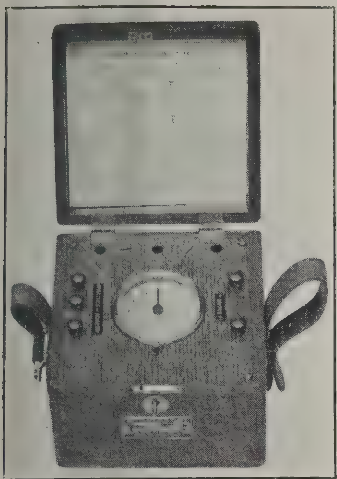
The Cord is Built to Withstand Mechanical Abuse

insulated with Okonite, braided with dry white and black cotton, and enclosed in a jacket of smooth, 60 per cent Para rubber compound.

This new product is designed for use in rough, wet or oily places.

Synchronous Timer for Testing Relays

The value of protective apparatus is often dependent upon the accurate timing of the control relays, and the General Electric Company is now manufacturing a synchronous timer which will measure the time interval in relay operation accurately. The timer operates on 50 or 60 cycles on a 110-volt circuit with a permissible voltage variation of 10 per cent.



General Electric Synchronous Relay Timer

The hands of the clock, mounted in the center of the case, are operated by a synchronous motor through a gear train. A friction clutch permits the starting and stopping of the hands with the motor running at synchronous speed, and this starting and stopping occurs within a fraction of a cycle so that the resultant error is not appreciable. A solenoid operated plunger normally engages a ratchet wheel and prevents rotation of the clock hands by causing the clutch to slip. When the solenoid is energized, the plunger releases the ratchet, allowing the clutch to hold. The ratchet will permit the hands to be turned back to the stop by means of the reset knob, but will not allow them to be turned forward. The hands of the clock may be stopped either by opening the solenoid circuit or by short-circuiting the solenoid and leaving the resistor across the line.

The clock has a standard clock face and hands, the large hand making one revolution for every 60 cycles of time, while the small hand moves five small divisions, or one-twelfth of a revolution, in the same time. The indicated time in seconds is, of course, dependent upon the frequency of the synchronous motor supply and one revolution of the large hand indicates 60 cycles.

A Flashlight That Requires No Battery

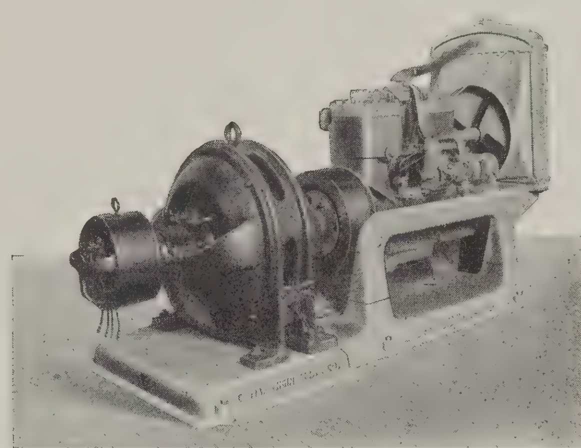
A hand-operated flashlight that requires no battery, called the Powerlite, is being marketed by the Martindale

The Powerlite in Operation

Electric Company of Cleveland, Ohio. Pressure of the fingers on the operating lever sets a small 6-pole fly wheel generator in motion and continued releasing and pressing the lever keeps the generator spinning. The generator supplies current for the operation of a standard 3.5-volt flashlight lamp. The proper speed can be ascertained by the light given. When not in use, the operating lever can be closed down against the generator housing or handle of the flashlight and held in that position by a locking button.

Gas Engine—Generator Set

The Climax Engineering Company has developed a new type of generating set consisting of a 75-kw. generator direct connected to a six-cylinder, 5½-in. x 7-in. gas engine, the complete set being mounted on a single cast metal base. Similar sets in which the prime mover is a four-cylinder engine are manufactured by the same company in sizes ranging from 15 to 50 kw. at 110, 220 or 440 volts, single, two, or three-phase, alternating current, and 110, 125, 220 or 250 volts direct current. The

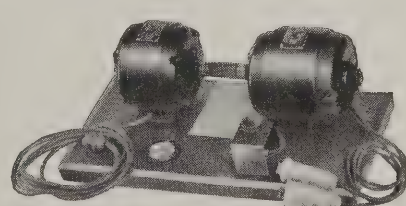


A 30-Kw. 37½-Kva., 2,300-Volt, 3-Phase, 60-Cycle Generator Driven By a Model T Four-Cylinder 5½-In. x 7-In. Gasoline Engine

engines used run normally at a speed of 800 r. p. m., with a maximum of 1,100 r. p. m., and are supplied for operation on either gasoline or kerosene for medium or heavy duty, continuous or intermittent service.

Battery Charging Set

A small motor-generator set for charging 6 and 12-volt storage batteries is now being made by the Ohio Electric & Controller Co., 5971 Maurice avenue, Cleveland, Ohio. The set consists of a low voltage generator and a single phase motor mounted on a single base and connected by a flexible coupling. An ammeter and a rheostat, also



Ohio Motor-Generator Set for Charging 6 and 12-Volt Batteries

mounted on the same base, are provided for regulating the charging rate. The charging rate can be varied from 0 to 20 amperes and the set is comparatively silent in operation. The motor is provided with 10 ft. of cord and an attachment plug and the generator has 6-ft. leads with convenient spring terminal clips.

General News Section

The Pullman Company is building 100 sleeping cars in its own shops.

The General Electric Company's storehouse at Rio de Janeiro, Brazil, was destroyed by fire on March 19.

The Bridgeport Brass Company announces the removal of its Chicago district sales office from the State-Lake building to the Wrigley building.

The Gibb Instrument Company, Bay City, Mich., manufacturers of electric welding equipment, has opened a sales office in Cleveland, Ohio, at 2104 East Superior avenue, in charge of W. O. Little.

The Metal & Thermit Corporation, New York City has appointed C. F. Lederer as general supervisor of rail welding in charge of all technical work in the field. This company will move its Pittsburgh branch into a new shop completely equipped with new facilities and located at 1514 Fayette street, N. S.

The Chicago & Eastern Illinois has instructed the Miller Train Control Corporation to proceed with the installation of its device on all new locomotives which are being received for service on its Chicago division. Six Pacific type and ten Mikado type locomotives are to be equipped.

According to a recent announcement made by H. P. Davis, vice-president of the Westinghouse Electric & Mfg. Co., Ray P. Jackson, manager of the materials and process engineering department, and Marsden H. Hunt will have charge of the new high voltage insulator plant of the company at Emeryville, California.

Radio communication was used by the Illinois Central on March 12 to get in touch with trains in territory cut off from regular communication by failure of wires during a storm. A message was sent out from two Chicago broadcast stations, requesting listeners to make inquiry of train dispatchers in their vicinity and report. The Hawkeye Limited, storm-bound west of Freeport for 10 hours, was thus located.

Work has been started on a 23-story bank and office building at 150 Broadway, New York City, which will be known as Westinghouse building. All of the space above the eleventh floor will be leased and occupied by the Westinghouse Electric & Manufacturing Company, together with the Westinghouse Electric International Company, the Westinghouse Lamp Company, the Westinghouse Air Brake Company and other allied organizations.

The Sprague Electric Works of the General Electric Company consolidated its district and local offices with corresponding offices of the General Electric Company April 1. The manufacture and exploitation of Sprague products will be continued in the name of the General Electric Company in the recently organized merchandise department. The Sprague conduit products section and the Sprague apparatus section of the merchandise department will, for the present, continue offices at 527 West Thirty-fourth street, New York City.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., on May 1, will remove its Pittsburgh, Pa., office of the Central district from the Farmers Bank building to rooms 950 to 953 Century building, on Seventh street between Penn avenue and Duquesne way. A. G. Pierce is manager of the Central district, with headquarters in Pittsburgh.

Chicago Fuse Mfg. Co. announces the retirement from active duties as president of Arthur D. Dana of New York City, to become chairman of the board and in order to devote more time to his other interests. William W. Merrill, who has been associated with Mr. Dana for many years, now becomes the president. The other officers are George C. Reid, vice-president and treasurer; Walter D. Dana, vice-president, and F. Trautmann, secretary. E. J. Hamilton will continue as manager of sales.

The Maine Central has completed plans for the construction at Rigby, South Portland, of a modern locomotive terminal, including roundhouse with capacity for 40 locomotives and facilities for running repairs of locomotives, together with the necessary accessories. Plans also provide for a large interchange and classification freight yard for the more prompt and economical dispatch of through freight business. It is expected that these facilities will be completed and available for use December 1, 1923.

The Southern Pacific has offered five 60-ft. chair cars, five 60-ft. coaches, fifteen 72-ft. coaches, fifteen 70-ft. baggage cars and one 72-ft. 6-in. combination coach and baggage car from the American Car & Foundry Company; sixty 72-ft. interurban coaches and ten 77-ft. dining cars from the Pullman Company; forty 70-ft. combination baggage and postal cars from the Standard Steel Car Company. All the above cars are to be of steel construction and all are for the Southern Pacific Lines except the one 72-ft. 6-in. combination coach and baggage car which is for the San Diego & Arizona.

The Standard Underground Cable Co., on April 1, moved its general offices and Pittsburgh sales office from the Westinghouse building, where they have been located for many years, to the company's new factory and office building at 100-108 Seventeenth street. The new building is a four-story brick and steel structure just completed and occupying the entire block between Sixteenth and Seventeenth streets. The company also announces the opening of a branch of its St. Louis sales office in the Scarritt Arcade building, 817-819 Walnut street, Kansas City, Mo. E. H. Shutt, who has been connected with the company for several years, will be in charge of the new office as district sales agent.

A number of changes in the Los Angeles office of the Westinghouse Electric & Manufacturing Company have been announced. The power division has been changed to the central station division, and J. C. Jones has been appointed manager. Mr. Jones is also in charge of the sale of supply apparatus in that territory. The railway division has been changed to the transportation division and G. B. Kirker has been appointed manager. A merchandising division has been established with J. H. Jamison as manager, and an engineering division has also been established with R. A. Hopkins as manager.

Association of Railway Electrical Engineers

At a meeting of the executive committee of the Association of Railway Electrical Engineers held in Chicago on March 10, it was decided that no semi-annual meeting of the Association would be held this year, but that the annual convention will be held in Chicago in October.

Speeding Up Swiss Electrification

The date for complete transformation of the Swiss Federal Railways has been advanced five years in order to ameliorate the unemployment situation in Switzerland. Complete electrification of the Federal lines by 1928 has been authorized by the Swiss Federal Council, according to reports received by the U. S. Department of Commerce. It has been planned to finish this work by 1933, but owing to the large number of unemployed in Swiss machinery and electrical industries, the general management of the Federal Railways requested an acceleration of the work. According to the new scheme, 75,000,000 to 80,000,000 francs are to be spent yearly instead of 50,-000,000 as heretofore planned.

The total length of line involved is about 1,000 miles, of which 250 are now completely electrified. The new program requires the providing of 215,000,000 francs sooner than would otherwise have been necessary, the total amount being 450,000,000 francs. It is expected that about 60,000,000 francs will be advanced by the Confederation to assist the railways in carrying out the new plan.

Power Apparatus for Chilean State Railways Development

The Compania Chileana De Electricidad, Ltd., Santiago, Chile, which has a contract to furnish power for the Chilean State Railways, has recently ordered from the Westinghouse Electric & Manufacturing Company 45,000 kva. of power transformers together with oil circuit breakers, bushing type current transformers and spare parts. The apparatus included in this order is to be used by the power company for transmitting power from their present system to the Chilean State Railways. Electrical equipment for the railway part of this development was ordered from the Westinghouse company some time ago. Much of it has already been shipped to South America and the balance is nearing completion in the East Pittsburgh works.

The apparatus included on this order is as follows: 3-7,500 kva. 3 phase, 50 cycle, 100,000 to 44,000 volt, oil immersed, forced cooled transformers; 3-7,500 kva. 3 phase, 50 cycle, 100,000 to 12,000 volt oil immersed, forced cooled transformers; 8-electrically operated type G-11 oil circuit breakers, outdoor, 400 amperes, 3 pole, single throw, 110 kv. for floor mounting; 13-type G-11, outdoor, 40 amps. 3 pole, 50 kv. frame mounted oil circuit breakers, together with necessary bushing type current transformers, control relays, auxiliary switches and necessary spare parts.

Electric Storage Battery Company and Willard Storage Battery Company

The consolidated statement of the Electric Storage Battery Company and the Willard Storage Battery Company for the year ended December 31, 1922, shows gross sales, less cost of manufacture, totaling $11,966,681, as compared with $10,015,812 in the previous year. Net earnings before payment of the federal income tax amounted to $7,570,839, against $5,602,383 for 1921. Dividends were paid totaling $3,196,685 in 1922 and $2,397,492 in 1921. The balance, December 31, 1922, was $21,957,765, as compared with $19,041,211 at the close of 1921.

The consolidated balance sheet as at December 31, 1922, follows:

Assets	1922*	1921
Cash	$2,485,474	$2,519,699
Bills and accounts receivable	5,354,555	3,997,543
Obligations of the United States	4,743,034	4,702,595
Industrial, railway and utility bonds	831,795	....
Accrued interest receivable	70,098	....
Inventories	7,928,280	6,960,133
Other investments	1,642,053	1,724,764
Deferred accounts	404,956	466,982
Real estate, plant and equipment	10,624,585	9,565,517
Patents, trademarks and agreements	11,000,001	11,000,001
Insurance fund, cash and securities	116,194	91,477
	$45,201,024	$41,028,713

Liabilities	1922	1921
Accounts payable	$2,321,025	$1,184,533
Accrued accounts	341,572	....
Sundry liabilities and prepayments	....	295,064
Reserves for unfinished contracts and contingencies	485,143	437,103
Reserve for insurance	116,194	91,477
Preferred stock	32,400	87,500
Common stock	19,946,925	19,891,825
Surplus	21,957,765	19,041,211
	$45,201,024	$41,028,713

*Subject to allowance for federal income tax for year 1922, estimated at $885,000.

Personals

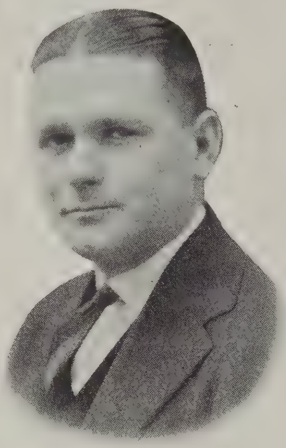
F. L. Pierce, treasurer of the Cutler-Hammer Manufacturing Company, Milwaukee, has been elected first vice-president and treasurer.

A. C. Goodale has been appointed branch manager of the Cutler-Hammer Manufacturing Company, with headquarters at Detroit, Mich.

W. P. Ballard, formerly superintendent of the Visalia Electric Railway, Exeter, Calif., has been appointed Industrial agent for the Southern Pacific System in the San Joaquin Valley.

C. F. Shadle, of the Shadle Automatic Train Signal-Stop Company, has several all connections with that company and with the Cincinnati, Indianapolis & Western Railroad. Mr. Shadle has been appointed chief engineer of the Indiana Equipment Corporation, and is the designer of the train control device being manufactured by this company.

Holcombe Parkes, associate editor of the Railway Age, who has also been associated with the Western Presidents' Committee on Public Relations and the Association of Railway Executives at Chicago, has been appointed editor of the Norfolk & Western Magazine, a new monthly publication of the Norfolk & Western, with headquarters at Roanoke, Va. Mr. Parkes was born on March 14, 1892, at Mt. Vernon, Ill., and received his education in the school of journalism at the University of Illinois. During his college course he was employed by the Pullman Company, in various capacities at different times. He was engaged for a time as a reporter for the Champaign Daily News of Champaign, Ill., and upon leaving the university was appointed wire editor for the Associated Press at Chicago. He was subsequently promoted to bureau manager and correspondent at Green Bay, Wis., and left this service on July 1, 1918, to become associate editor of the Railway Age at Chicago. He continued in this capacity as news and labor editor until 1921, when he also became associated with the Western Presidents' Committee on Public Relations and the Association of Railway Executives. Mr. Parkes was serving in this capacity at the time of his recent appointment as editor of the Norfolk & Western Magazine.



H. Parkes

Dr. Cary T. Hutchinson, is now associated with Sanderson & Porter, engineers, and will direct the department of railroad electrification of that firm. For thirty years he has been engaged in handling railroad electrification problems. In 1891 the firm of Sprague, Duncan and Hutchinson built the first heavy electric locomotive constructed in this country for Henry Villard, who was then considering the electrification of the Chicago freight terminals. The Baltimore & Ohio engaged Duncan & Hutchinson as consulting engineers for the first steam railroad electrification in the United States built through Baltimore in 1896. From 1906 to 1908, Dr. Hutchinson was engaged by The Great Northern Railway to take charge of the design and construction of the electric equipment of its road over the Cascade Mountains. Later, the Illinois Central, which had under consideration the problems involved in its Chicago terminals, appointed Dr. Hutchinson a member of its Electrification Commission. He was selected in 1920 to take charge of the railway electrification division of the Superpower Survey, for the results of which he is responsible. He initiated and was the chief engineer of the 100,000 horse power hydro-electric development on the Susquehanna River at Holtwood, Pa., which supplies Baltimore, and he has been connected, as consulting engineer, with important hydro-electric developments in California, Canada and Mexico. Dr. Hutchinson was also for a time in charge of the department of electrical engineering at Johns Hopkins University, and has written a variety of engineering papers on pertinent mathematical and physical topics. Sanderson & Porter, who for many years have been prominent in engineering, construction and management work for public utilities and industrial corporations, have now determined to extend their activities to include railroad electrification.

Dr. Cary T. Hutchinson

Trade Publications

Safety Switches.—"The Switch with a Conscience" is the title of a card bulletin issued by the Super-Safety Electric Switch Company, 1200 West 104th street, Chicago, Ill., which illustrates and describes the features and characteristics of the dead front safety switch manufactured by that company.

Squirrel Cage Induction Motor.—The Louis-Allis Company, Milwaukee, Wis., has issued a 16-page bulletin, profusely illustrated, which describes and gives full information covering the new L-A, type HD heavy duty induction motor with a one-piece rotor winding, which was recently developed by that company.

Lighting Data.—A new group of bulletins on the general subject of lighting have recently been issued by the Edison Lamp Works of the General Electric Company. The titles of the bulletins, together with a brief statement of the contents follow:

The Lighting of Paper and Pulp Mills.—This is a reprint of a paper presented before the Technical Association of the Paper and Pulp Industry by J. H. Kurlander of the Edison Lamp Works.

Office Lighting.—The latest practice in office lighting is pictured and the most recent developments in suitable equipment are discussed.

Light and Safety.—This is a reprint of a bulletin previously published which includes minor changes and additions.

Mazda Lamps Theory and Characteristics.—This is also a revised bulletin in which the characteristic curves have been revised and extended in range, making them more generally useful.

The Manufacture of the Edison Mazda Lamp.—This includes a description of a new method of packing with the 6-lamp carton.

A 22-page bulletin on the subject of street lighting and public safety has also been issued by the National Lamp Works of the General Electric Company.

Railway Electrical Engineer

Volume 14 MAY, 1923 No. 5

Fall Convention of the A. R. E. E.

In the last issue of the *Railway Electrical Engineer,* a notice was published regarding the omission of the regular semi-annual meeting of the Association of Railway Electrical Engineers in June. The same notice also mentioned the annual convention to be held in Chicago in October. Since the publication of this information we have been advised that the fall meeting will come this year a little later than usual. The convention will take place at the Hotel La Salle, Chicago, November 6 to 9 inclusive.

Virginian to Electrify

The Virginian railway will electrify its lines between Roanoke, Va., and Mullens, W. Va. The distance between these points is 134 miles and the track mileage to be electrified is 213. The total cost of the work will be $15,000,000. A contract covering the electrical equipment for this installation was awarded on May 1 to the Westinghouse Electric & Manufacturing Company.

The section to be electrified includes that part of the Virginian railway on which the heaviest grades are encountered. The heaviest grade is the 2 per cent grade opposed to eastbound traffic which lies west of the summit of Clark's Gap. The traffic handled consists almost entirely of coal moving from the New River and Pocahontas districts to tide-water at Hampton Roads and this traffic has been expanding rapidly for a number of years. These facts have caused the management to adopt electric traction and, incidentally, award the largest single contract for electrification which has ever been placed. Further details regarding the undertaking are published on page 131 of this issue.

During the past 20 years many predictions, relative to the electrification of steam railroads, have been made which range from the conservative to the most extravagant estimates, but the actual developments during the past five years have failed to meet even the most conservative predictions. Shortly before and after 1916, many studies of electrification projects were made which indicated the economic feasibility of many of the projects. Immediately after this period, however, economic and industrial conditions brought about largely by the war compelled the postponement of action, pending the return of railroad conditions to a more nearly normal state. Among these were at least half a dozen major electrification programs which were most promising in their engineering and economic aspects and all of which had been held in abeyance since the early part of the war. It appeared that the majority of these programs would become active or be undertaken whenever railroad and industrial conditions warranted, and, there are now ample indications that railroad and industrial conditions have reached a state that these projects may and very probably will be re-opened.

If these projects are re-opened, it will mean an activity in electrification which will exceed anything which has been predicted prior to this time. The general improvement of the railroad situation indicates that these projects may be re-opened and for further indications there are the present activities of a number of the roads as follows: The purchase of additional electric locomotives by the Pennsylvania as well as the active study of a considerable electrification program of main line operation; the definite decision of the Illinois Central to electrify its terminal service in Chicago; the decision of Henry Ford to electrify the Detroit, Toledo & Ironton; the recent extension of the Norfolk & Western electrification and the purchase of additional new locomotives, the first to be purchased since the inauguration of electrical operation of this railroad; a recent addition of a considerable amount of electric motive power on the New Haven; and finally the largest undertaking of its kind in America, the contract for the electrification of the Virginian.

The revival of activity in electrification shows a confidence in the future of American railroads and indicates that the period of postponement of electrification activities has reached an end. It is time that the railroads take advantage of the tool electric motive power has given them; enough has been learned by experience to insure the intelligent adoption of electric traction, to prevent its recommendation where it is not warranted, and with the generally improved railroad conditions and available proof of the economic value of electrification, we can reasonably expect an unprecedented activity in this field.

Are Detail Cost Records Worth While?

Not very long ago we published an article on the subject of record keeping in connection with car lighting maintenance and there is no doubt but that in the particular case in question, the keeping of these records was entirely justified. They were justified for the reason that use is made of the records; that is, they serve the purpose of keeping up a high standard of maintenance at all times. There is another angle to the keeping of records, however, which is sometimes overdone and that is the keeping of records which never have been and never will be of any value. Occasionally, we find someone who has carried the system

of record keeping to the extreme, so much so that valuable time is spent upon the work of tabulating data which is only filed away and never used at all. This is particularly true in the keeping of cost records in car lighting maintenance. Cost records may be valuable when such records are actually referred to for the sake of reducing subsequent costs but if these records are tucked away and never used, the time consumed in preparing them is a total loss. It has been suggested that the information more often desired is—how much does it cost to keep cars electrically lighted? This can be very simply arrived at by merely totaling up the yearly wages of the men in the car lighting department; then adding to this sum the amount which the inventory shows has been used during the year, and finally include the amount of power which the wattmeter indicates has been consumed. It certainly would seem that the result is what the cost of car lighting is to any particular road and the labor involved in arriving at it is very little indeed. What do you think about it?

The Development of Welded Tanks

Electric arc welding is gradually but surely becoming a more and more important factor in the construction and maintenance problems of the industrial world today. It is but a short time ago that the welding of pressure vessels was frowned upon by many who were supposed to be best informed on the subject, but the art of welding has developed so rapidly that pressure vessels, especially unfired pressure vessels, are being welded today with perfect certainty as to their success.

The one great difficulty which electric arc welding has had to contend with has been the work of poor welders. Practically all of the failures which have occurred and which have been so detrimental to the progress of welding can be traced directly back to the work of some careless or improperly trained operator.

Exhaustive tests made upon unfired pressure vessels at Washington, D. C., some time ago proved conclusively that a tank can be welded with absolute satisfaction, provided the work is done in the correct manner. In the tests referred to, good, fair and bad welds were made on the same material. The welds which were classified as good were of double V type and welded clear through. Fair welds were welded 1/3 of the way through from each side, while the poor welds were made from one side only and extended through about 2/3 of the thickness of the plate. The results of the test showed the double V welds to be much superior in all cases, the average strength of the double V weld being 97 per cent of the strength of the plate and in some particular cases being as high as 103 per cent of the strength of the plate. Since the plates themselves were not of uniform strength, the welds may be considered as practically 100 per cent. In all cases of double V welding, no rupture occurred in the weld.

The most satisfactory tanks were those with head concave to pressure. No leaks were developed at working pressure or anywhere near it. Tanks designed for 160 lb. went as high as 1,800 lb. before rupture. It was found that ⅝-in. plate was about the limit that was practical to use and that as far as the quality of material was concerned, low carbon steel plate was best. In using plate of high tensile strength such as 100,000 lb. per square inch, it is impossible to get a weld which will be the equivalent of such plate and for this reason, the low carbon steel plate is more desirable. In testing the strength of welded tanks the best method to use is the hydrostatic. The pressure should be run up about one and a half times the working pressure. Striking the tank with a hammer while it is under pressure is not generally considered a test of much value but in the case of welds of cast iron, the hammer test may be used and should there be any strain in the metal, this test will develop it.

In brief, it may be said that the welded tank is no more dangerous than the riveted tank provided double V welding is used. That some of the insurance companies were convinced of this is manifested by the fact that they insure welded pressure vessels on the basis that the weld is 85 per cent of the strength of the plate and this is all that is allowed for riveted seams.

New Books

EMF Electrical Year Book. Edited by Frank H. Bernhard. Bound in cloth, 1,030 pages, illustrated, 9 in. by 12 in. Published by the Electrical Trade Publishing Company, 53 West Jackson Boulevard, Chicago, Ill. Price $10.

This is the second edition of the EMF Electrical Year Book, compiled by the Year Book staff and 36 contributing editors. The book is a completely revised and enlarged cyclopedia, dictionary and trade directory covering the entire electrical industry. Nearly half of the original 14,000 or so topics have been either entirely rewritten or radically revised, and several thousand new topics have been added. Among the definitions, of which there are over 5,600, are electrical terms ranging from the highly theoretical to purely practical. There are several hundred cyclopedia topics, giving facts and figures on each branch of the industry, on the leading lines of electrical development and of equipment, lists and data of national and sectional electrical associations, electrical periodicals, libraries, colleges, laboratories, etc.; also about 90 biographies of electrical scientists and inventors. The trade directory feature includes about 3,150 classifications of electrical and closely related products, for each of which are given listings of manufacturers; there are also separate entries of the manufacturers under their approximately 6,600 company or firm names; likewise, there are nearly 6,800 separate trade name entries.

The following are specific examples of the material contained in the book: There are four articles on steam railroad electrification by Edwin B. Katte, chief engineer electric traction, New York Central; articles on railroad signaling, automatic train control and related topics by K. E. Kellenberger, editor, Railway Signal Engineer; several hundred topics on electric railways and equipment by C. C. Beck, Ohio Brass Company, etc. The list of contributing editors includes college professors, electrical engineers and many specialists and the book is a valuable reference as well as a fruitful source of information.

Interior Wiring and Systems for Electric Light and Power Service. By Arthur L. Cook. 2nd Edition 458 pages illus., diagrs., tables, 7 in. by 4 in. Bound in fabrikoid. Published by John Wiley & Sons, New York. Price $3.00.

Intended as a guide to modern practice in electric lighting and power applications and in the design and installation of the wiring for these purposes. Written particularly for superintendents of electrical installations and for wiremen.

Virginian to Electrify Heavy Grade Division

Project Will Include 134 Miles of Line and Will Cost $15,000,000 —Single Phase System Will Be Used

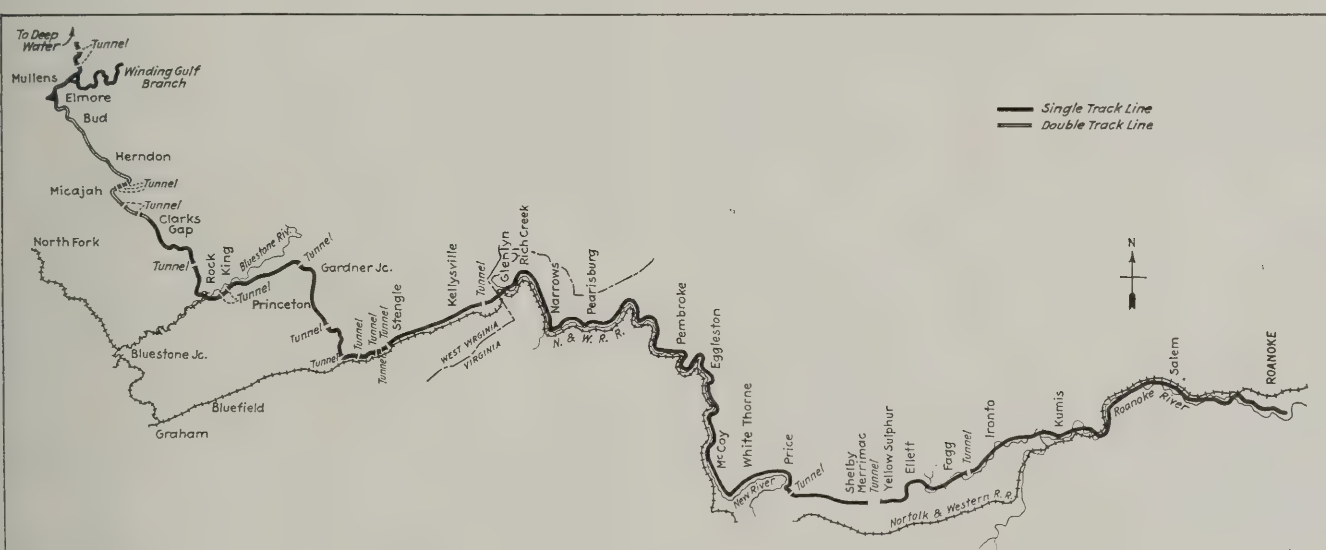
THE Virginian Railway has decided to electrify 134 miles of line, including 213 miles of track, lying between Roanoke, Va., and Mullens, W. Va. The division to be electrified crosses the Allegheny Mountains and includes the 1.979 per cent grade, compensated, from Elmore to Clarks Gap up which eastbound coal must be moved before it starts on its down hill journey to tidewater. The undertaking will involve the expenditure of $15,000,000 and the contract for electric locomotives, power house equipment, transformer stations and other electric apparatus has been awarded to the Westinghouse Electric & Manufacturing Company. This is the largest railroad electrification contract which has ever been placed. The alternating current, single phase system with 11,000 volts on the trolley will be used.

Power for operation of trains will be generated by a 90,000-hp. generating plant to be erected on the New River. This will supply alternating current power at 88,000 volts to a transmission line which will extend from Roanoke to Mullens. This line will parallel the railroad approximately and will, in turn, supply power to substations where it will be stepped down to 11,000 volts for the trolley. Apparatus on the locomotives will still further reduce the voltage and will convert the power to three-phase current for the operation of the traction motors.

A feature of the project will be the use of regenerative braking on ground grades. This will greatly assist the control of trains and it is estimated that it will also save 15,000,000-kw. hours of electric energy per year.

The principal reason for electrifying is that greater power can be applied to each train thereby resulting in economy of operation and in increased capacity in this heavy grade district. Three Mallet type locomotives are used to move 5,500-ton trains over the ruling grade at a speed of seven miles an hour. The combined power of the three locomotives is about 7,000 hp. The new electric locomotives will develop 20,000 hp. per train and will haul 9,000-ton trains over the same grade at a speed of 14 miles an hour. The Westinghouse Company has stated that it will be entirely practicable in the future to further increase this power so that 12,000-ton trains can be handled at the same speed.

The traffic of the Virginian Railway is predominantly bituminous coal; that commodity normally constitutes over nine-tenths of its total tonnage. This coal is secured from the New River and Pocahontas districts, and by far the larger part of it moves eastward to tidewater at Hampton Roads. The road was built by Henry H. Rogers of the Standard Oil Company, who desired an independent outlet for the extensive coal properties in West Virginia in which he was financially interested. It has a total main line mileage of 442 and its total mileage is 526. It is divided into four operating districts, the eastern three of which are built with grades opposed to eastbound traffic of but 0.2 per cent with the exception of a single short stretch of 0.6 per cent. The three districts mentioned constitute that part of the line from Princeton to Sewalls Point, Norfolk, 348 miles, and on this section of the road, the train movement is in effect dropping the trains down hill to Tidewater. The line from Princeton west to the terminus at Deep Water does not have by any means the same favorable grade line as the other three districts. This district, known as the Deep Water district, is in the coal fields where the traffic originates. The coal tonnage received from mines on the main line or on the Winding Gulf branch is assembled at Elmore which is near the western end of the line included in the electrification project. From Elmore eastbound for a stretch of 11 miles, there is a rise with a compensated grade of 1.979 per cent to the summit of Clarks Gap. This, for many years, was the "neck of the bottle" of the Virginian's op-

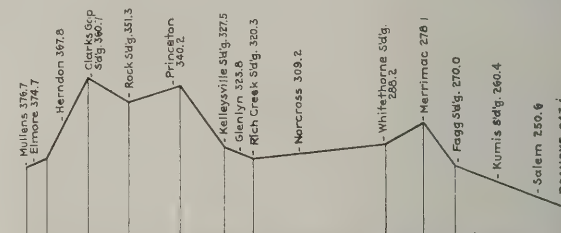


Map of the Virginian Railway from Mullens, W. Va., to Roanoke, Va.

erations. A short while ago, however, the management carried out a project of double tracking and tunnel widening which, with the use of heavy power, has relieved the situation very materially. In fact, the situation was changed to the extent that more of a problem was offered to the railroad in moving the trains down the 1.5 per cent descending grade from Princeton east 12 miles to Kellysville. The problem was one of braking the trains and it was largely as a consequence of this situation that the Virginian has been something of a leader in the use of the empty and load brake.

The Virginian, as a part of its program of securing heavy train loads, has resorted to the use of the 120-ton, 6-wheel truck coal car and there are in use on its lines the heaviest steam locomotives in service in the world. The usual method of operation is to handle the train assembled at Elmore up the 1.979 per cent grade to Clarks Gap with three locomotives of the Mallet type. The leading locomotive in the normal method of operation is a Mallet locomotive with tractive effort ranging from 70,800 lb. to 101,300 lb., depending upon the class, with two helpers of the 2-10-10-2 type cut in the train. These locomotives are the largest steam locomotives in service and their size is indicated by the fact that their tractive effort working simple is 176,000 lb. and compound, 147,200. The Virginian has 10 such locomotives. It is the usual procedure to cut the helpers out at Clarks Gap, the train then moving with the single locomotive from there to the end of the division. These details are given because it is this service in which the electric locomotives are to find their place.

The Virginian in recent years has had a very marked expansion in its traffic. The figures for 1922 are not at present available but because of the fact that the Virginian had handled non-union coal, they will, presumably, be the largest thus far in the company's history, this result obtaining because of the heavy traffic handled during the strike of the bituminous miners in the union districts. The expansion in traffic has required the management to carry out a number of important improvements in the property. The double tracking of the line between Elmore and Clarks Gap has already been mentioned. Another was the recent improvement in the yard and terminal facilities at Elmore and the shop facilities at Roanoke and Princeton. The road also has plans for an additional coal dumping pier at Sewalls Point where it already has facilities capable of dumping 90 cars per hour when working at capacity. It has gradually been extending its lines in the coal districts, this work including the construction of a



Miles *		5.06	10.32	10.05	12.97	10.90	7.21	32.72	9.51	7.43	27.56
Elevation		1427.05 / 1528.42	2525.55	2232.61	2438.16	1674.13	1554.94	1700.65	1966.57	1445.86	926.0
Compensated Grade-Per Cent	East	+.531	+1.979	−.396	+.402	−1.259	−.340	+.168	+.583	−1.252	−.313
	West	−.228	−1.681	+.710	−.198	+1.395	+.391	−.024	−.475	+1.400	+.401
Maximum Grade %		1.21	2.11	1.25	0.60	1.50	0.808	0.20	0.60	1.5	0.9
Aver. Curve Deg.		3.79	3.73	3.93	2.55	1.70	0.64	1.80	1.35	1.85	1.10
Max. Curve Deg.		12°	12°	12°	8°	8°10'	3°	8°	8°	8°	8°
Miles from Norfolk (From Mile Posts)		376.73 / 371.67	361.36	351.33	338.40	327.49	320.29	287.57	278.10	270.67	243.11

* Survey Equations Included

Condensed Profile of the Virginian Railway from Mullens, W. Va., to Roanoke, Va.

subsidiary line termed the Virginian & Western, 15 miles in length, and an extension of the Winding Gulf branch, totaling slightly over two miles. The larger part of the road's present tonnage comes from the New River field; but, the future holds out the possibility of gradually increasing tonnage from the Pocahontas district from which the road already receives considerable traffic. The present electrification project is the latest step in this improvement and extension program.

Electric operation will permit much greater expansion of traffic over the existing track, and regeneration of electric power should greatly simplify the difficult problems to be met, particularly on the 1.5 per cent descending grade east of Princeton. The undertaking is the first large electrification to be instigated since the war and it is expected that electric operation will be started in about 18 months.

Grade Separation at Ampere, N. J., on Delaware, Lackawanna & Western

Electrical Operation of Machine Tools

Remote Control Equipment Applied to Individual Motors Materially Reduces Maintenance and Operating Costs

REMOTE control automatic starters and automatic compensators for the control of individual motors driving machine tools in the Silvis shops of the Chicago, Rock Island & Pacific, have proved so successful that the installation of such equipment is being extended.

The illustration, Fig. 1, shows a grinder driven by a 7.5 hp., 3-phase, 60-cycle, 440-volt a.c. motor made by the Cleveland Electric Motor Company. The control station, or push button box, which controls the starting and stopping of this motor, is mounted in the small steel box *B* on the machine directly in front of the operator. This control station energizes the magnets in the automatic compensator shown mounted on the wall at *C* in Fig 2. The magnetic contactors in the compensator first start the

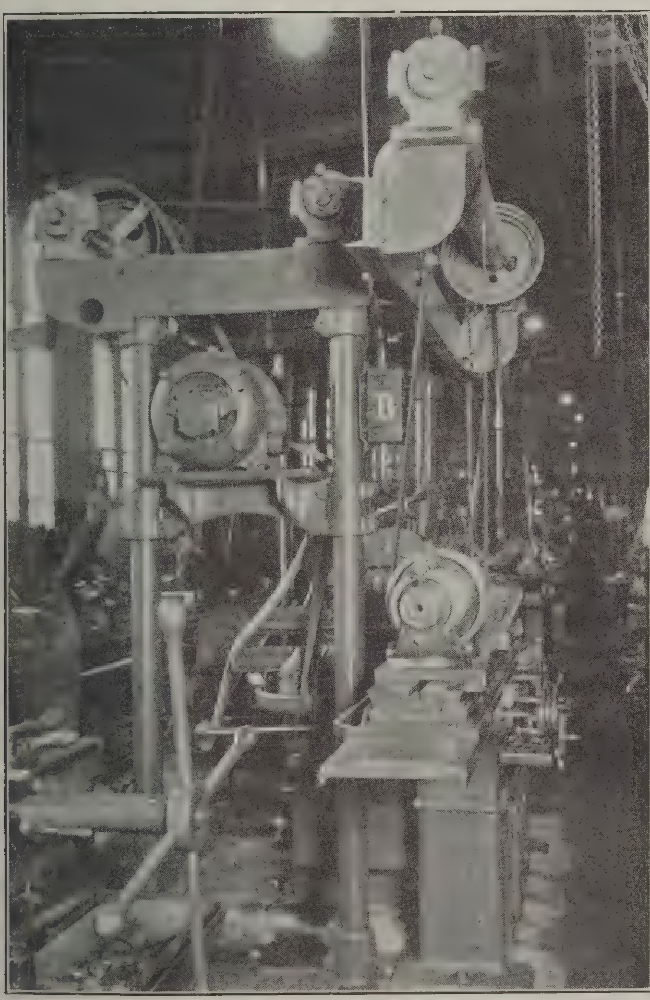


Fig. 1—Tool Grinder Showing Control Button Box Handy for Operator

motor on reduced voltage through the compensator transformers and, after a proper interval, throw the motor directly on the 440-volt line. The period of acceleration is adjusted in the control station. A stop button disconnects and stops the motor.

The advantages of automatic remote control for electrically driven machine tools are numerous. The push button station may be mounted wherever most handy for the operator. It takes up little room and, as it carries only the current of the pilot circuit of the compensator, it can be connected with small wires and conduit. A push button is the easiest means of starting or stopping a motor, therefore a man will habitually stop and start his motor when the machine operation is not continuous, resulting

Fig. 2—Automatic Compensator for Grinder, Mounted on Wall, Out of the Wall; Shown With Open Door

in a saving of power. With a hand operated compensator, the man would be forced to walk over to the wall to stop the machine. As a result, he would waste his time or waste electric current. The automatic compensator saves valuable machine shop space; it can be mounted in the most out of the way position. It frequently saves wiring cost, as the compensator can be mounted near the motor with a censequent saving of heavy line wires and conduit.

Another great advantage of the automatic compensator is that the operator cannot start his motor too quickly, which would result in strains on the motor, belts, gears and machine tool. The control station can be adjusted for the proper accelerated period and then sealed. It will exactly repeat that starting period regardless of what the operator may do.

These automatic compensators are equipped with low voltage magnets which protect the operator and machinery against sudden and unexpected starting upon the return of current after a power failure. They also have

overload relays of the dash pot type, which protect the motors and line from excessive current whether caused by overloads or by single phase operation.

Considering that there are some 400 motors used for various purposes in this shop, the protection given by automatic starting equipment has reduced the maintenance and operating costs considerable.

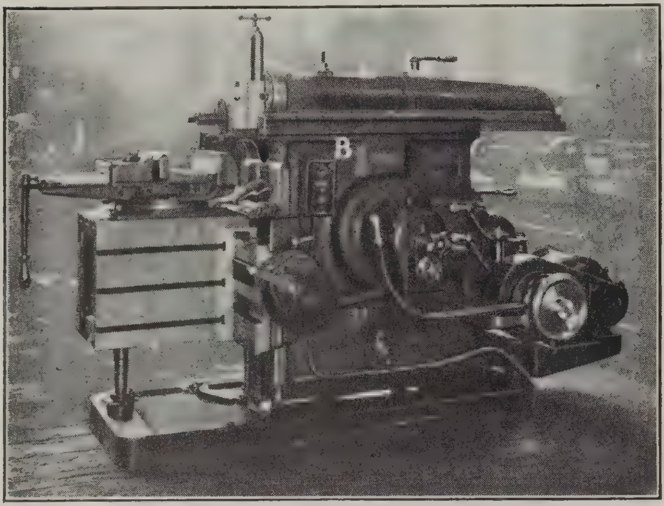


Fig. 3—Shaper With Control Button Station in Handy Location

Description of Typical Installations

In Fig. 3 is shown a shaper with direct motor drive. The start and stop control station can be seen mounted at *B* beside the operating levers, immediately in front of the man operating the machine, where he can stop or start the machine with the least possible effort. This is especially useful in setting up a job, for a quick stop for a hard spot in the iron or when the clamping or tool holder works loose. The automatic compensator for this unit is mounted on the wall as shown in Fig. 4.

Fig. 4—A Row of Automatic Compensators Mounted on the Wall

In Fig. 5 an automatic compensator is mounted directly on the frame of a large bed planer. A control station is mounted beside the compensator cabinet. Other control stations might be mounted on other parts of the planer, so that the motor could be started or stopped from two or more points. When more than one control station is used a lockout button is provided on each station for the safety of the operator. When this lockout button is pressed, the motor cannot be started from any other station until the lockout has been released. In this equipment the advantage of the automatic compensator is that the motor cannot be started too quickly. It also assists in setting up a job.

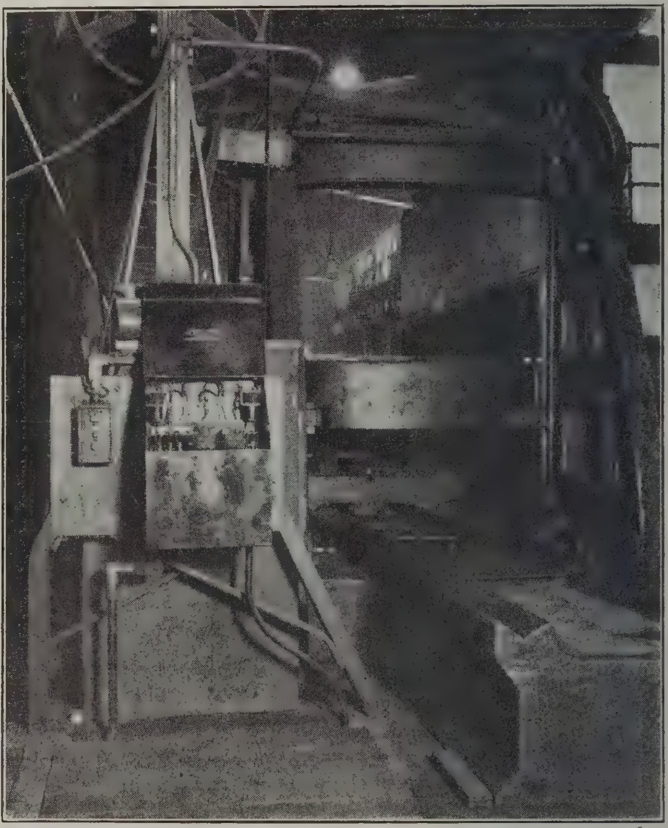


Fig. 5—Control Station and Automatic Compensator Side By Side on Bed Planer

The portable type lathe shown in Fig. 6 can be carried about by the overhead crane and set down wherever needed, being used principally for fitting frame bolts, etc., requiring special fits. The 5 hp. 230-volt d.c. motor used for driving this lathe is mounted on the main support of the lathe. The start and stop push buttons are mounted just to the left of the hook, on top, while the automatic starter is under the right end of the machine in a steel cabinet with the door open. The 230-volt d.c. power for this machine is carried through a flexible two-wire cable, from an Oliver Electric & Mfg. Co. safety type receptacle, one or more of which is located on every column at the edge of the main construction bay. The automatic starter gives push button operation and regulates the starting period of the motor. The automatic compensator and remote control equipment for the machines shown in Figs. 1, 2, 3, 4, 5 and 6, were furnished by the Industrial Controller Company, Milwaukee, Wis.

The electrically controlled equipment on the large Niles-Bement Pond Company bed planes shown in Fig. 7 automatically stops and reverses the direction of motion of the planer bed. This motor, a 20 hp. 230-volt d.c. machine, is started by closing two manually operated circuit controllers, which have an automatic overload release feature. The operation of the switch to control the reversal of the motor may be adjusted by moving the lugs on the side of the planer bed.

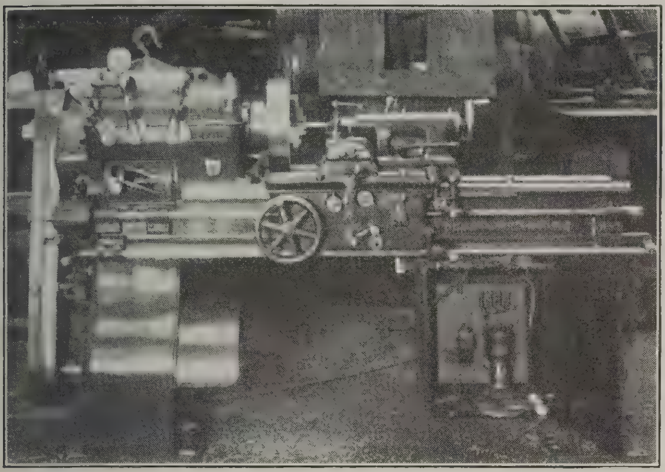


Fig. 6—Portable Lathe With Controller Equipment on Lathe

The large locomotive wheel lathe shown in Fig. 8 is driven by a 50 hp. 230-d.c. volt motor and the General Electric Company type automatic switching equipment is shown in the cabinet with doors open. There are three buttons for the control of this machine, a start, a stop and a slow button. The ability to slow down the lathe for hard spots is a great advantage. The main control station is mounted on a bench in front of the lathe while a second push button is placed on the rear side of the lathe to be used for quick starting and stopping while adjusting the set-up.

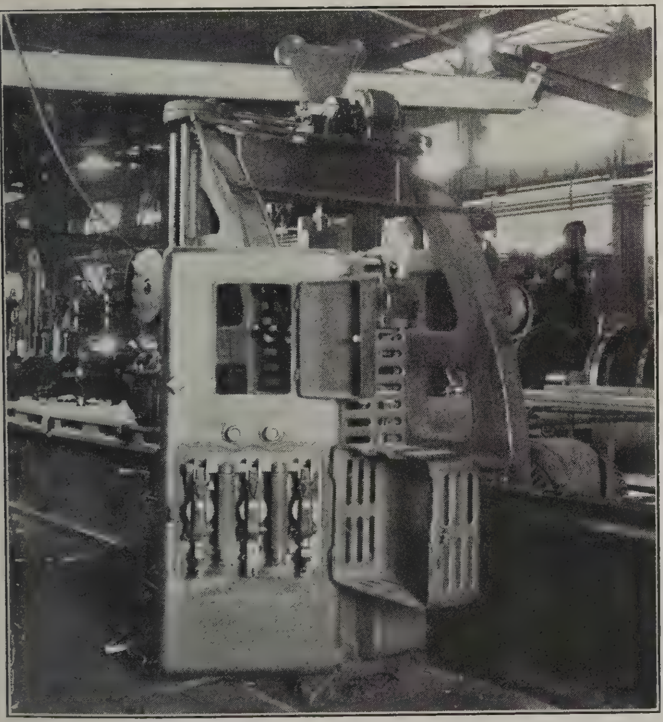


Fig. 7—Niles-Bement-Pond Bed Planer with Automatic Reversing Motor Controller

Some of the smaller machines in the side bays are grouped and driven from short line shafts. The motor for such a line shaft is controlled automatically. In some cases a single set of start and stop buttons is located on the wall and in other cases a separate set of buttons may be placed on each machine so that the line shaft can be started and stopped only when needed by a man desiring to use any one of the machines.

Explanation of Controller Circuits

The Industrial Controller Company automatic compensator consists essentially of a transformer, two oil-break magnectic contactors for connecting the transformer to line and motor and two time limit relays for giving overload protection. All of these are mounted within a single enclosing case and all parts are accessible. The diagram in Fig. 9 shows the circuit connections for the a.c. push button control station and automatic compensator as used for the 7.5 hp. a.c. motor driving the shaper shown in Fig. 3.

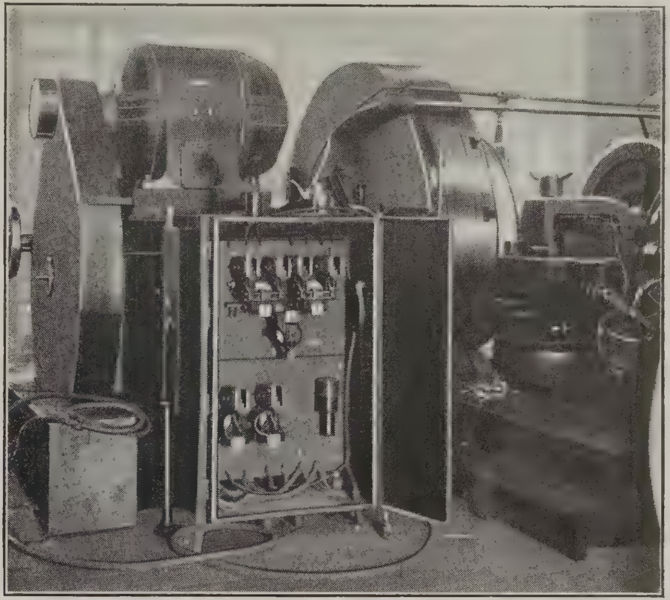


Fig. 8—Large Wheel Lathe With General Electric Automatic Control Panel

The 3-phase 440-volt a.c. power is fed in through a 3-pole knife switch and fuses at S to the three line terminals $L1$, $L2$ and $L3$.

The motor is started by means of the two magnetic contactors mounted inside the oil tank. These contacts are controlled automatically by the control station.

When starting the motor, the left hand or four pole contactor F first closes, connecting the auto-transformer to the line and the motor to the transformer taps. After a short interval of time, long enough to allow the motor to nearly reach full speed, this contactor opens, and the right hand or double pole contactor R, closes and connects the motor directly to the line.

The D. C. Automatic Starter

The circuit connections for the automatic starter used for the d.c. motor driving the portable lathe shown in Fig. 6, are shown in Fig. 10. The 230-volts d.c. power is

brought to the two line terminals *L1* and *L2* and after going through the knife switches and fuses one side goes directly to the motor. The other side of the circuit is taken to the contactor of an automatic rheostat with resistance units marked 1, 2, 3 and 4. It should be noted that one side of the shunt field is connected to the first terminal of this rheostat. As the apparatus functions to bring the motor up to speed the resistance is cut out of the armature circuit and cut into the shunt field circuit.

Control Stations

The type *K-1* control station usually supplied with each compensator is provided with a timing device, which controls the operation of the magnetic contactors. This device is similar to a clock movement in operation and is set in motion by pulling down the starting lever on the outside of the cover. Each time the motor is started the contact wheel on the timing device makes a complete revolution, closing the control circuits leading to the contactors at the proper intervals of time by means of the two contact fingers engaging the wheel. The time of acceleration can be altered by raising or lowering the weight on the pendulum rod. This time is adjustable from 5 to 16 seconds approximately.

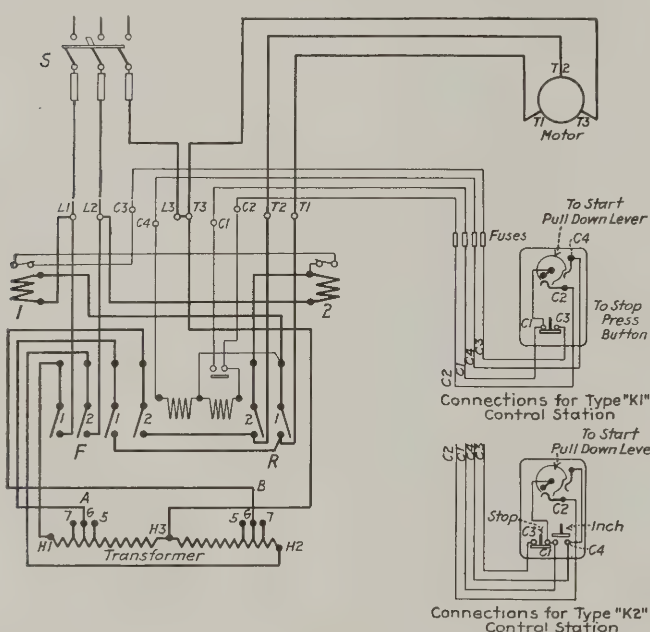


Fig. 9—Wiring Diagram for Three-Phase Automatic Compensator, With One Type K-1 or K-2 Control Station

In addition to the timing device there is also provided a push button which is normally closed. In order to stop the motor the button is pushed in, which opens the control circuit. If this button is pushed clear in as far as it will go it engages a latch which holds it in this position. The lockout latch can be released by pushing an auxiliary button just above the stop button.

When it is necessary to stop the motor immediately after starting, before it has been brought up to full speed and while the compensator is still in the starting position, the stop button is pushed clear in so as to be held by the lockout latch. The button remains in this position for a few seconds until the timing device completes its cycle and comes to a stop.

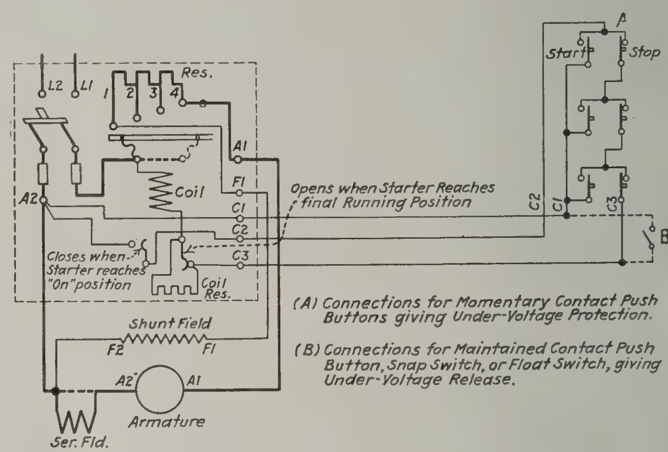


Fig. 10—Direct Current Automatic Starter Type E

When more than one control station is used with a compensator, the lockout device may be used for "locking out" other stations. As long as the stop button is held "in" it is impossible to start the motor from any control station.

The control station may be furnished with an extra push button for "inching." This is useful in cases where it is desired to "inch" or "jog" the motor for putting on belts, or for other reasons. When this button is pressed in it throws the compensator to the starting position and holds it in this position as long as the button is held in. When the push button is released the motor will stop.

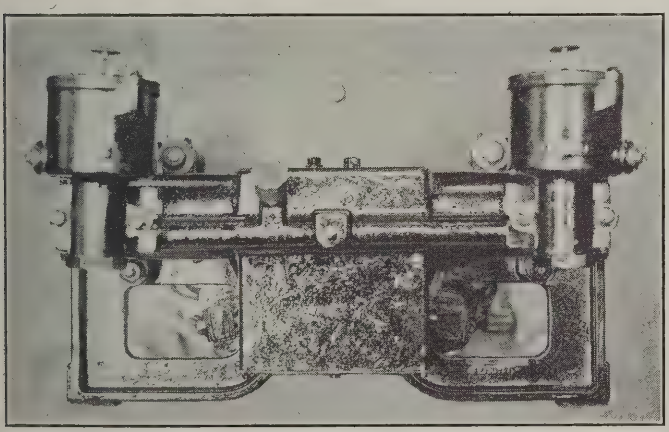
Harbor at Vera Cruz

The Power House at Bluestone Which Supplies Power for the Electrified Zone of the Norfolk & Western

Electric Locomotives for the Norfolk & Western

Traction Motor Power Factor at Full Load Will be 95 Percent — Locomotives Will Develop 4000 HP.

FOUR new electric lomocotives have been ordered through Gibbs & Hill, New York City, by the Norfolk and Western. Announcement of this order was made in September, 1922, issue of the *Railway Electrical Engineer.* The locomotives are being built by the



Cam Switch Group for Starting Auxiliary Motors

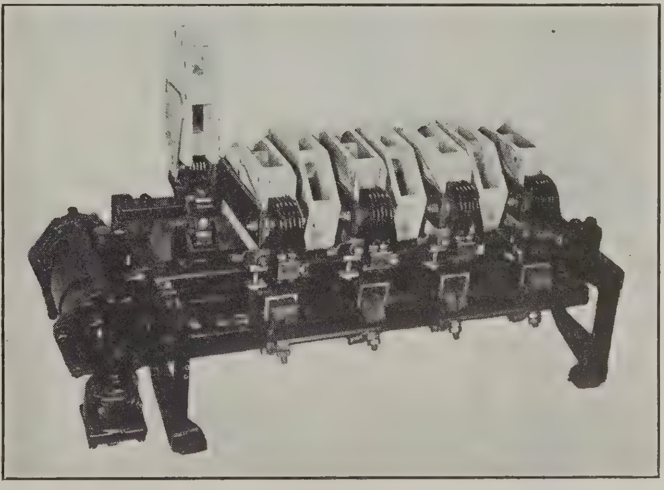
American Locomotive Company and the Westinghouse Electric & Manufacturing Company and will have approximately 30 per cent greater hauling capacity than those now in operation.

The 12 original locomotives which have been in service since 1914 are of the split-phase type which take 11,000 volt single-phase current from the trolley and transform it inside the locomotive to the three-phase power at a voltage suitable for the induction type traction motors. Twelve of these locomotives, when placed in operation, retired 33 mallet type steam locomotives and in the opinion of the railway company's operating officials, more than doubled the capacity of the road.

The new locomotives, like the original ones, will consist of two cabs permanently connected to form a locomotive. The equipment in each cab will be identical, so that any two cabs can be coupled together, back to back, to form a locomotive unit.

The principal dimensions of the cab and wheel arrangement are as follows:

Wheel arrangement	2-8-2 and 2-8-2	
Right wheel base	16 ft.	6 in.
Length over coupler faces	97 ft.	2 in.
Total wheel base	83 ft.	0 in.
Height from rail to top of cab proper	13 ft.	5 in.
Height from rail to top of clerestory	14 ft.	9 in.
Height from rail to pantagraph in lock down position	15 ft.	10 in.
Maximum width over side sheets	10 ft.	5 in.
Diameter of driving wheels over tires	62 in.	..
Diameter of truck wheels over tires	....	33 in.



Cam Operated Switch Group for Short Circuiting the Secondary Windings of the Traction Motors

The design of the cab and running gear is the result of the combined study of the railway company and their consulting engineers, Messrs. Gibbs and Hill. It embodies all the improvements thought necessary as a result of the present operation, and is especially designed to meet the

severe service to which it will be subjected. Several unique features have been incorporated.

The cab structure is fastened rigidly to, and is carried by the side frames. This is contrasted with the previous construction of the cab supported by springs and sliding bearings. The side frames are vanadium steel castings connected by cross ties which are also used to support the heavier pieces of electrical apparatus mounted in the cab. The four pairs of drivers of one cab are in a single truck, whereas two trucks of two pairs of drivers each, connected by a mallet hinge, are used on the previous engines.

The spring suspension arrangement is of the Mikado type embodying side equalization between the leading truck and its adjoining two driving axles and cross equalization between the other two driving axles and the trailing truck.

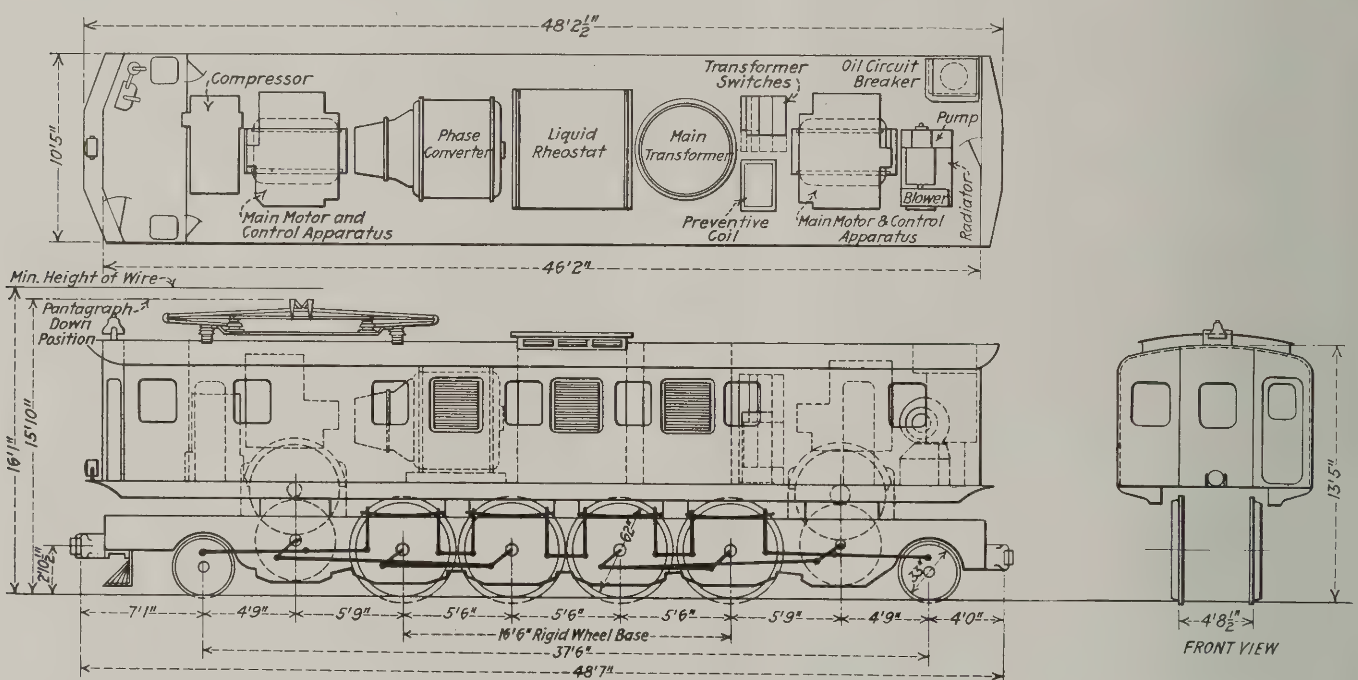
Ease of removal of the jack shaft and its bearings is an outstanding feature of the locomotive. The jack-shaft is carried in heavy bronze bearings, split vertically, which rest on a steel casting or collar. These are set in the side frames between accurately fitted pedestal ways. The collar casting itself is provided with a tie bar arranged so that the collar becomes almost an integral part of the side frame, and in no way weakens the latter's strength. This application follows closely the arrangement on the previous locomotives.

The locomotive cabs and mechanical parts are now being built by the American Locomotive Company, and when completed will be shipped to the works of the builder of the electrical equipment and the gearing, the Westinghouse Electric & Manufacturing Company, where the electrical equipment will be mounted and the locomotives tested before shipment to the railway company is made.

A flexible gear mounted on each end of the jack-shafts transmits the motor torque by means of side rods to the driving wheels. The springs are inserted without initial compression, and are so designed that they do not become completely compressed until a torque is exerted equivalent to a locomotive adhesion of 110 per cent.

In the design of the main motors, the Westinghouse Company has followed closely along the lines laid down in their design of motors for the experimental split-phase locomotive of the Pennsylvania Railroad built in anticipation of the Altoona grade electrification. In the case of the present locomotive, however, only one motor per jack shaft is provided as compared with two motors per jack shaft on the previous Norfolk & Western locomotives, and on the Pennsylvania Railroad locomotives just mentioned.

Structurally, the motor is of the induction type with a wound secondary arranged so that it can be connected for either four or eight poles, corresponding to locomotive speeds of approximately 28 mph., and 14 mph. respectively. Collector rings are provided to connect the secondary windings to liquid rheostats which provide starting resistance. These collectors are mounted on the ends of the motor shaft to provide ready accessibility and ease of inspection.



Plan, Side Elevation and End View of One Locomotive Unit Showing Location of Apparatus

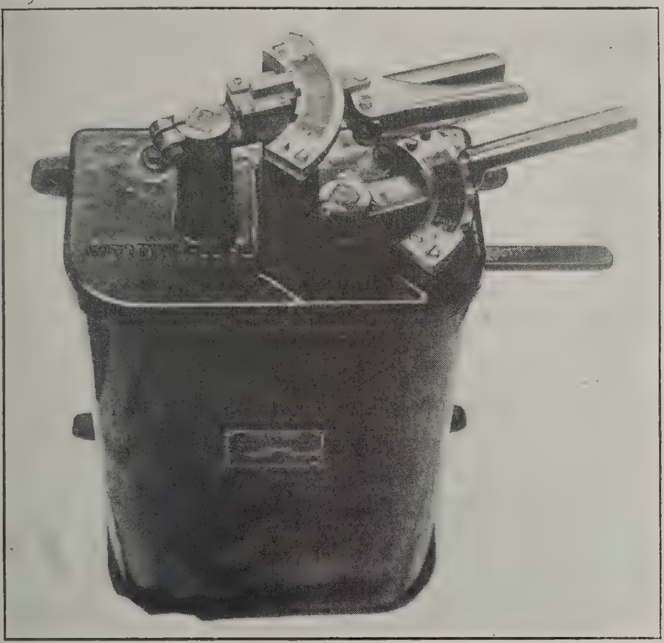
The nominal rating of the traction motors on the one hour basis is 1,000 hp. each. Four motors of one complete locomotive unit are capable of developing a tractive effort of 90,000 lb. continually at 14 mph., and 52,500 lb. continuously at 28 mph. On a basis of the one hour rating, the tractive efforts developed are 108,000 lb. and 63,000 lb. at 14 mph., and 28 mph. respectively.

A new and interesting feature of this locomotive is the use of an oil insulated force cooled transformer. The transformer back is cylindrical in shape with its upper end projecting slightly above the cab roof. The oil insulated type of transformer has been almost universally used in a single-phase European electrification, but up to this time the air blast transformer has been the standard in this country in all trunk line installations.

The phase converter is of the synchronous type. The stator is wound essentially like a two-phase induction motor. The motor is wound for direct current excitation

by means of which the locomotive power factor may be controlled so that at full load it will be approximately 95 per cent. The phase converter is started by means of a small single phase commutator type motor mounted directly on its shaft, arranged so that when its starting function is completed, it is reconnected as a separately excited d.c. generator to furnish the current for the phase converter motor. Separate excitation for the d.c. generator is obtained from the control generator and the storage battery.

The phase converter stator windings are so arranged that one of them acts as a driving winding for the motor. The other winding has a voltage generated in it which has approximately a 90-degree phase relation with the transformer voltage. By combining this voltage with the transformer secondary voltage in accordance with the usual two-phase-three-phase connection, balanced three-phase voltage is produced at the traction motor terminals.



Master Controller, One of Which is Located in Each Locomotive Unit

By means of a balancing transformer preventive coil, normal motor voltage is maintained with a 15 per cent drop in trolley voltage during accelerating, and with a drop in trolley voltage of half this value during normal running.

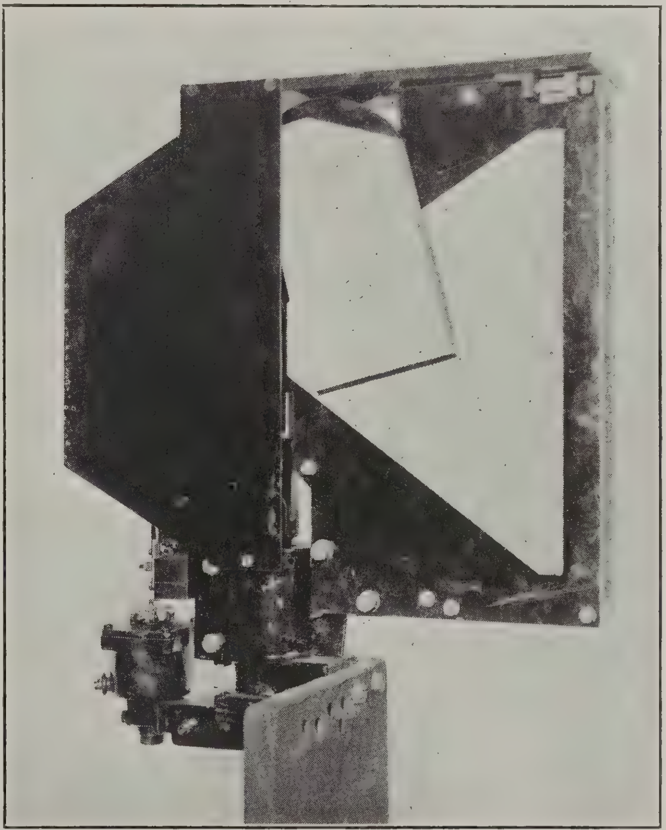
Cooling of the oil insulated transformer is accomplished by means of pumping the oil through a force ventilated radiator. A simple motor supplies the energy to drive both the oil pump and the blower for the ventilating air.

Ventilation of the traction motors is accomplished by a motor driven blower set for each motor. These motors are identical in design to the motor for the combined blower and pump set and to the motor driving the pump which circulates the electrolyte in the liquid rheostat, the only variation being in the shaft extension. This practically accomplishes interchangeability of all auxiliary motors.

Following previous practice on the Norfolk & Western Railway, the generator furnishing the energy for the control, charging the storage battery, and exciting the d.c. exciter for the phase converter is chain driven from the shaft of the phase converter. It has a capacity sufficiently large so that in the event of a control generator failure in the adjacent cab, one generator can furnish the excitation for both exciters.

In the design of the liquid rheostats, the Westinghouse Company has improved materially on any rheostat of this type supplied heretofore. The rheostats for both motors of one cab are contained in a common tank with a common storage supply. This insures the same electrolyte strength in both rheostats. By means of a common valve, motor operated, and controlled from the master controller, the electrolyte in both rheostats is raised uniformly and at the same rate. By special arrangement of the control, the movement of the electrolyte valves in two cabs can be so related that an equal division of load on all four motors of one locomotive is assured.

One of the features of the previous Norfolk & Western locomotives was an arrangement of the control whereby, in the event of one of the trucks of a locomotive losing its adhesion, full torque could be maintained on the three trucks holding the rail while the torque on the fourth truck was reduced until slipping has stopped when the torque of this truck was raised to a value equal to the others and the acceleration continued. By means of four push buttons located close to the master controller, the engineman can lower the torque on any motor of the locomotive, and on releasing the push button, the torque of this motor will be raised to that of the others automatically.



One of the Motor Switches

Pneumatically operated cam type switches are used for the arrangement of the traction motor circuits for either the 14 m. p. hr. connection, or the 28 m. p. hr. connection. The control is so arranged that during transition from

one speed to the other the torque of only one-half the locomotive is momentarily lost while making the change in motor connections. This follows exactly the arrangement now existing on the Norfolk and Western locomotives.

A motor driven air compressor is provided on each cab (two per locomotive) having a displacement of 150 cubic feet of free air per minute against a pressure of 130 pounds per square inch. This motor driven compressor set is designed for continuous operation and has sufficient capacity to charge the long trains commonly operated by the railway company. The reservoir capacity per locomotive will be approximately 125,000 cubic inches as an extra safeguard to insure complete charging of long train lines.

The service to be performed by these locomotives is the most severe to which any electric locomotive has ever been subjected. The traffic consists of heavy tonnage coal trains of 4,000 tons hauled up six miles of 2 per cent grade, on a road noted for its curves. The speed of the train up this heavy grade with two locomotives is 14 m. p. hr. Acceleration of these trains on the 2 per cent grade standing on heavy "S" curves is part of the normal operation.

Leadizing Process for Protecting Electrical Conduit

The Atchison, Topeka & Santa Fe for the past three years have been leadizing all electrical conduit installations in engine houses to secure better protection from the gases which corrode iron rapidly. Two methods have been used, namely, the hot dip process and the process of leadizing by means of depositing the lead by reaction with lead acetate. The first method was developed in the test department of the Santa Fe by R. J. Shoemaker and the second method was also perfected by Mr. Shoemaker after he became engineer of tests of the Magnus Company.

Hot Dip Process

To leadize conduit by the hot dip process, it is first necessary to clean the conduit of all grease and oil. To do this it is immersed for three hours in a vat of 20 to 30 per cent lye or caustic soda solution at a temperature of 120 deg. F. It is then removed and washed with clean water.

Second, it is necessary to remove all other foreign substance and scale and to accomplish this, the conduit is immersed for 45 minutes to one hour in a 50 to 70 per cent solution of muriatic acid at a temperature of 120 deg. F., the length of time varying in proportion to the strength and the temperature of the acid solution.

The pipe is coated in a two part vat of convenient size, the two halves of the vat being separated by a steel plate extending to within 6 in. of the bottom of the vat. Zinc chloride is held on one side of this partition and molten lead on the other. The conduit is pushed down into the zinc chloride which is used as a flux and thinned with salt or sal ammoniac. As soon as the conduit is heated thoroughly, it is pushed down under the partition and drawn out through the lead, which has been previously heated to 625 deg. F. The conduit is then dipped into water. This cleans off any zinc chloride which may have adhered to the conduit and exposes any parts of the pipe which have not been coated due to the fact that the pipe was not thoroughly clean. In case there are any parts to which the lead did not adhere, the process is repeated.

Lead Acetate Process

The conduit is first cleaned and prepared in the same manner as for the hot dip process. The coating is applied by using a solution consisting of 70 per cent lead acetate, 10 per cent muriatic acid and 20 per cent water which is heated to 140 deg. F. The cleaned pipe is placed in this solution for from 30 to 40 minutes, depending upon the size of the pipe, the larger pipes taking the greater time. The conduit is then removed and dipped in clean water to set the coating.

After the conduit is received for use in a certain location, the electricians also leadize the threads which they make in fitting up the conduits, as it has been found by service that the failure of conduits occurs first in threaded portion. When a heavier coat of lead is desired than that which is put on by the lead acetate process, more lead can be added by plating it on the pipe or conduit from a regular plating generator with a lead anode in a bath containing acetate of lead and iron sulphate.

The conduit may be bent without injury to the lead coating and it has been found in the case of rivets treated by this process that if hammered cold they will preserve their original lead coating.

Lead coated pipe has been in service on the Santa Fe at Topeka since 1917 and recent examinations failed to show any depreciation. These pipes were used for carrying water and were buried in cinders. In another case where lead coated pipe was subjected to constant moisture in a drainage manhole, the lead coating remained intact and the only indication of service was a slight blackening of the surface. The leadizing process has proved so satisfactory that it is now used by the National Boiler Washing Company for coating steel plate used in the fabrication of tanks for boiler washout and filling systems. Lead plated rivets driven sold are used in the construction.

C. P. R. Station at Lake Louise, Alta.

Recent Developments in the Arc Welding Field*

Constantly Increasing Applications in Both Maintenance and Manufacture Mark the Progress of the Welding Art

At the present time welding in some form or other is quite extensively used in repair work, and in some cases is used exclusively for manufacturing purposes. Rapid progress has been made in the art of welding during the last twenty years, and we who keep in close touch with everyday welding applications do not realize the importance of the advancements that are being made from time to time.

The American Bureau of Welding which is the welding research department of the American Welding Society and National Research Council organized some ten research committees to investigate important problems and to standardize welding practice. These committees have been functioning in an energetic manner, and some of them have already completed reports of their activities.

Standardization Activities of the American Bureau of Welding

Standard Tests for Welds.—In May, 1921, the committee on "Standard Tests for Welds" submitted a report. This report contains a complete outline of tests necessary for shop, commercial, and research standards, together with a standard procedure for mechanical testing, including tensile, bending and fatigue tests on the base metal, weld metal, and weld. The standard sizes and dimensions of test specimens are illustrated by diagrams and a short description of standard fatigue testing machines is given. This set of standards marks the starting point of standardization in the welding field.

It is more significant when one realizes that the chief difference between testing a specimen of steel that includes a welded joint and testing an ordinary specimen is the non-homogeneity of the welded specimen. The welded specimen has at its center a section composed of material that usually has physical, chemical and metallurgical characteristics distinctly different from the adjoining metal. Furthermore, the section of the added metal is more or less irregular in shape and variable in size. Consequently the procedure prescribed for testing ordinary specimens is not applicable to specimens containing welded joints. Differences in details of procedure have caused such widely divergent results that the value of much of the research work on record up to this time has been greatly restricted. In many cases the results are actually misleading.

Welding Wire Specifications.—The next report submitted was "Welding Wire Specifications." This report was published in December, 1921. It included specifications for iron and steel bare electrodes and iron and steel gas welding rods, also recommended standards for coated or covered electrodes and gas welding rods for welding high carbon steel and non-ferrous metals. Chemical analyses, physical properties, sizes, marking, and materials are specified or recommended in detail. This report is the result of over a year's work by the committee and embodies all of the data available at that time.

Standards for Arc Welding Apparatus.—In June, 1922, six months later, there appeared in the Journal of the American Welding Society, a report "Standardization Rules for Electric Arc Welding Apparatus" submitted by a sub-committee of the Arc Welding Committee. From the preface to this report we learn that several types of arc welding apparatus are now being sold, but at the present time there is no agreement among the manufacturers of arc welding apparatus as to the basis of rating. A prospective purchaser is bewildered by the confusing claims that special merits pertain to the different machines on the market and, unless he has had previous experience in welding, he has no sound basis for comparing the capacities of the several makes.

This report of the sub-committee of the Arc Welding Committee contains a list of standard definitions, a classification of apparatus, and an outline of the information required to be furnished by both the supplier and the purchaser of arc welding apparatus. The committee, recognizing the Standards Committee of the A. I. E. E. as the authoritative body controlling the standardization of electrical apparatus, submitted these standards for their consideration. The A. I. E. E. Standards Committee appointed a sub-committee which has revised and enlarged the draft submitted and is now prepared to submit tentative standards.

It must be remembered, however, that the standards which have been thus far completed are simply the beginning of a broader and better standardization which is being carried on as the welding art progresses. Each member of the Welding Society should feel it his duty to give constructive criticism on any point which may be incorrect or lacking in the present drafts.

General Reports and Research Work of the American Bureau of Welding

Arc Welding of Cast Iron.—This report presents a summary of the art of arc welding cast iron as it exists today, outlining the difficulties which have been encountered, and the degree of success which has been achieved. The report is divided into two parts.

In the first part, existing methods of carbon arc welding of cast iron are discussed briefly. Three methods of welding cast iron with the use of studs and the metallic arc are described and illustrated. The physical properties of cast iron which affect arc welds are discussed and corrective measures are suggested. Considerable space is given to comments by men experienced in the art of cast iron welding without the use of steel studs, and it is interesting to note that there is quite a divergency of opinion among welders as to whether cast iron can be successfully welded with or without steel studs. A bibliography is included for the convenience of those who are interested in a further study of the subject.

The second part of the report "Arc Welding of Cast Iron" deals with the research work. The committee has drawn up a proposed program of research and the report consists mainly of a description of the work which the

*Abstract of a report presented at the annual meeting of the American Welding Society, April 25, 1923, by W. L. Warner, assistant to chairman of the electric arc welding committee of the American Bureau of Welding.

committee has done in carrying out this program. Specifications were drawn up and a series of tensile tests made on some seven different electrodes. Diagrams and charts give the results of these tests in a graphic form, and these results are also tabulated.

It is interesting to note that some of the tests show a joint efficiency ranging as high as 78 per cent on one grade of cast iron tested and 85 per cent on the other, there being two grades of cast iron used. These results demonstrate that it is possible to weld some grades of cast iron if the proper method and conditions of welding are obtained. The specimens were made through the courtesy of the General Electric Company and New York Central Railroad.

Specifications for Steel to Be Welded.—In the welding industry, the need has long been felt for a more complete and accurate knowledge of the effects of the many variables which influence the success of a weld. A valuable contribution to our fund of information on this subject is found in a progress report of the Committee on Specifications for Steel to be Welded. The authors of the report developed a method which they propose for testing the suitability of various materials for welding purposes.

Before such a test could be developed, however, it was necessary to determine what constitutes a satisfactory material to be welded. It is generally agreed that a sound weld can only be obtained when the metal fuses evenly and quietly and without excessive sputtering and boiling. This means a material thoroughly degasified and low in gas forming elements. Freedom from slag or slag-forming constituents is also essential. With these things in mind three methods were tried.

The first method consisted in coating with vitreous enamel some sixteen-gage strips one and one-half inch wide of various metals. This enamel was baked on by passing an electric current through the strips, heating them uniformly to the proper temperature. The materials tested consisted of (1) commercially pure iron made in a basic open hearth furnace, (2) copper bearing open hearth iron, (3) basic open hearth mild steel, (4) charcoal iron, (5) Bessemer steel and (6) silicon steel. The iron samples produced a perfectly smooth enamel surface free from defects, while the steel samples showed bubbles and blisters in the enamel. This indicates that such iron has a freedom from gas and gas forming constituents.

Another set of one and one-half inch sixteen-gage strips was prepared but no enamel was applied. The strips were heated by an electric current as before, and the current was gradually increased until the strip finally fused in two. The behavior of the samples near the fusion temperature was found to be characteristic of the materials. The iron samples melted quietly while the steel samples threw out a shower of sparks and left a very rough surface after fusion.

The report gives striking evidence of the difference in behavior under fusion between various kinds of steel and iron. Those having a low carbon content such as commercially pure open hearth iron displayed a remarkably smooth surface under the fusion tests. Such iron fused sharply without gas evolution and sparking and flowed freely when molten. On the other hand mild steel when tested showed a quite different result. The steel effervesced during heating and boiled and bubbled near the fusion point. However, mild steel with a carbon content of 0.15 is one of the most readily welded materials.

Unfired Pressure Vessels.—For some time the A. S. M. E. Boiler Code Committee has been preparing a code for unfired pressure vessels similar to the boiler code.

To show that pressure vessels can be welded safely and to secure data for the Code Committee on this subject by actual tests, a committee was appointed at the April, 1922, meeting of the American Welding Society to study the problem. Several hundred letters were sent to manufacturers and others, and several replies were received. Several concerns agreed to furnish tanks and to contribute funds to test them to destruction. These tests should settle the questions at issue, the most important of which is the following, "What test will always detect an unsafe vessel?"

Welding Oil Storage Tanks.—There are many advantages of a welded tank over a riveted one. One of the most important of these is the elimination of leakage which in a riveted tank represents a loss of about 5 per cent. This loss in a 5,000-bbl. tank represents $1,250, which capitalized at 6 per cent. amounts to $20,000. It is also probable that with a little practice the cost of erecting a tank by the electric welding method will be lower than the cost of similar tank erected by riveting.

The report of the Committee on Welding of Storage Tanks contains recommendations for constructing a 5,000-bbl. tank, and a number of alternate constructions are suggested. Figures of the details of construction of the bottom, sides and roof are given.

Welding Applications

In addition to the work that has been done under the auspices of the American Bureau of Welding, many investigations have been caried on by independent investigators. Some interesting applications of the welding process have been discovered and have been brought to a certain degree of development, although many phases are still in the experimental stage.

Hammer forging has been shown to greatly improve the strength, ductility and fatigue resistance of metal deposited by the electric arc. A few years ago welding currents of the order of 125 amperes were in most common use. This has gradually been increased until 200 amperes is now not unusual. For large thermal capacities 300 amperes is sometimes used with coated electrodes. This type of electrode has been very much improved and appears likely to lead to the arc welding of non-ferrous metals. Indeed, the arc welding of brass with a flux-covered type of copper electrode is already commercial in England.

Railroads.—During the last few years an unusually rapid advance has been made in both electric arc and oxy-acetylene welding, and they have now become recognized as arts very essential to many industries—particularly the railroad industry. H. J. McCracken and F. J. Hickey, of the Southern Pacific Railroad, in the January, 1923, issue of the *Railway Electrical Engineer* described the uses to which arc welding is put in the Sacramento shops.

There are many instances where either oxy-acetylene or electric arc welding can be used, such as the welding of boiler tubes, repairing fire boxes, flue sheets, locomotive frames, making of car end sills and many others. The sleeves of flexible stay-bolts are welded to the wrap-

per sheet by the electric arc. A particularly advantageous feature of the electric arc weld is afforded through the concentration of the intense heat in a small area, enabling it to be applied just where it is needed without heating up much of the adjacent material.

The most successful applications of welding undoubtedly have been in places where thorough supervision and training of welders have been carried on. No matter what kind of material is to be welded, or what the type of welding is, the reliability of the weld rests in a large degree with the operator.

Locomotive Shops.—In the field of locomotive construction and repair great progress has been made. Edward H. Heidel, boiler foreman, C. M. & St. P. R. R., describes the application of arc welding to locomotive boiler construction for welding fire boxes, door sheets and collars, and crown sheets. Great stress is laid on the point that only experienced welders should be allowed to make welds in fire boxes or for any pressure work. C. W. Roberts, welding foreman, Pennsylvania Railroad, Columbus, Ohio, describes some of the uses and abuses of arc welding in locomotive work as follows:

"In electric arc welding, as in everything else, there are limitations, and an efficient supervisor will know these limitations. He will refuse to go beyond them, as he knows such work only leads to the condemning of the entire practice of electric arc welding.

"The most frequent causes of failure are inefficient and indifferent workmen and the little heed taken to have a perfectly clean properly prepared job. Suitable equipment and proper electrodes for the work at hand should not be overlooked. The finished result probably is 90 per cent. operator, and 10 per cent. equipment and materials, while preparation and operation are about a 50-50 break."

Mr. Roberts described several examples of welds made on various parts of locomotives, such as cross heads, side sheets, door collars and flues. Electric welding gives a stronger seam than riveting, and there is never any future work necessary, such as caulking. The cost of riveting firebox seams runs from $0.90 to $1.25 per lineal foot, while with the metallic electrode the total cost is approximately $0.35 per lineal foot. It is not possible to secure these good results unless the operator is a man of experience and knows what he is doing. Under these conditions arc welding gives excellent results. Mr. Roberts has secured arc welds with an efficiency as high as 96 per cent.

Welding Monel Metal

Attempts to arc-weld monel metal have in the past not proven particularly successful, whether by the carbon or the metallic arc method. In such trials the general experience was that it was difficult to produce consistently, welds which were sound and free from blow-holes, ductile and free from shrinkage cracks. The Research Department of The International Nickel Company has during the last year attempted to develop satisfactory arc welding practice for the metal. The particular object sought was to develop a method of producing sound and ductile welds free from cracks.

It seems apparent from a consideration of the first difficulties encountered in arc-welding that the metal melted by the arc absorbs sufficient oxygen from the surrounding air, and that it requires redeoxidation in order to make it again malleable and sound. It may be observed that special deoxidation is not necessary in oxy-acetylene welding because the operator uses a reducing flame which protects the hot and molten metal from the air.

Dr. P. D. Merica and Mr. J. G. Schoener have made some tests using deoxiding coatings which show a remarkable difference between welds made with bare monel wire and wire covered with a deoxidizing coating. The agents which have been found to be superior for this purpose are the same as those used in the foundry, viz.: Magnesium, manganese, and silicon, in the order of their importance for this operation.

The results seem to indicate that the arc welding of monel metal is entirely possible when the proper reducing flux is used, and in that case the process is not essentially different in detail from that of steel welding. One important variation, however, is that of making the welding rod positive instead of the work. It is also best to build up the weld all in one operation and not to build it up in successive layers, as the latter method will likely give cracks and unsoundness.

Manufacture of Pure Iron

For Welding Wire.—The continuous progress in the art of arc-welding has necessitated large scale production of welding material in this country. In the first commercial application of arc-welding Norway iron was principally used as a welding material, but as the demand grew there was a shortage of the Norway product. It was, therefore, desirable to produce in this country a similar metal, purer if possible, made on a more modern basis.

Research has shown conclusively that claims of the advantages of using welding material of an analysis similar to the base or parent metal, particularly when welding mild steel, are not sustained, and the reason for this can be fully understood when it is considered that arc welding is in many respects analogous to re-casting metal. To expect a cast metal of a similar analysis to possess the identical physical characteristics of a rolled and specially treated sheet of plate, is asking more than could possibly be obtained.

Inspection of Welds.—Methods of determining strengths of welds without destroying them have been sought for some time. Tests were made to determine electrical conductivity and tensile strength. A study of the data shows that even with this simple testing means, an increase of voltage across the weld signifies a decrease in weld strength. Further activity in the utilization of both magnetic and electrical test methods has shown the possibility of detecting, in the laboratory, differences in weld strength of the order of 10,000 lbs. per square inch. The apparatus employed, while not commercial in its present form, could be made adaptable to numerous welding structures.

Steel Structures.—Within the past six or seven years some steel structures have been built with neither pins nor rivets. The members were connected together by arc welding, and this development in the art of steel construction is now making rapid progress.

Within the last few months an electric sign for the radio station WGY was constructed of structural steel and every joint was arc welded. This sign stands 22 feet high and the letters are 10 feet in height. The base of the sign is approximately 10 feet by 20 feet.

Arc Welding Apparatus

Electric arc welding apparatus has been developed to such an extent that it has now become an important factor in the welding field. Major James Caldwell has admirably described the latest types in a paper presented before the Institution of Electrical Engineers, England, December 14, 1922.

Automatic Metallic Arc Welders.—The automatic arc welders made by the General Electric Company utilizes a constant energy welding source. The electrode is fed to the arc from a reel by means of feed rolls actuated by a 30 volt motor which is shunted across the arc when the arc is struck. Regulation of feed is maintained by two contactors which change the direction of rotation of the feed motor when the arc voltage increases or decreases above or below a certain amount, respectively. The machine acts in the capacity of a single welder operator except that a steady arc is more easily maintained. This machine does very good work on straight seams and regular shapes and several variations are now used.

Semi-Automatic Welders.—One slight variation from the principle of the automatic machine described above is a semi-automatic welder also manufactured by the General Electric Company. This machine feeds the welding wire through a flexible conduit to a welding nozzle in which the control switch for the feed motor is located. This control mechanism operates to start and stop the feed motor. The maintenance of a uniform and steady arc depends on the operator so that it is not necessary to reverse the feed motor as in the case of the full automatic welder. This type of machine is somewhat more portable than an automatic welder.

Automatic Carbon Arc Welder.—During the past year the Lincoln Electric Company has put on the market an automatic carbon arc welding machine. In this machine the welding wire is placed on the work before welding. The heat of the carbon arc fuses both the wire and base metal forming the weld. Very high speeds are thus made possible.

Alternating Current Contactor.—One of the notable achievements made during the past year in the field of alternating current arc welding apparatus has been the development of a safety switch which cuts the power from the welding line and primary circuit whenever the arc is not being drawn. The voltage at all times during welding is limited to a harmless value such as 30 volts.

Artesian wells are quite prevalent in the northern and middle parts of Florida, the necessary pressure evidently coming from some northern elevation, perhaps the Appalachians. It occurred to a local inventor with some vision that a water pressure upward is, as a source of power, just as good as the usual pressure downward. So he developed some small reaction turbines which could be mounted directly over an artesian well. They are made in sizes from 150 watts to 2,000 watts, directly connected to 32-volt or 110-volt direct-current generators. A storage battery is used with each outfit, and the main purpose of the generator is that of charging the battery continuously at a low rate.

The conditions are such that no centrifugal governor or electric regulator is necessary, and the outfit is exceedingly simple. Since an overflow is desirable, anyway, to keep an artesian well in a good condition, the farmer gets his light and power and still has his irrigation water. This method for producing power locally can be applied to advantage in several localities along the Gulf Coast where these artesian wells are found.

Attention has recently been drawn by the Provincial Minister of Lands and Forests of Quebec to a number of new projects now under way for the purpose of developing and utilizing the enormous water power possibilities of the many falls and rapids of Quebec. Contracts for two important water power developments have recently been let, one of these being in connection with the rapids of the Grande Decharge of Lake St. John, while the other is a development located on the Outarde River on the north shore of the coast. It is expected that within the next five years a minimum of at least 230,000 horsepower will be developed at a cost of $12,000,000.

Lethbridge Viaduct on the Canadian Pacific

Basic Principles for the Electrical Workman

A Series of Articles Explaining Clearly the Reasons Underlying the Operation of Simple Circuits and Apparatus

By K. C. Graham

Part 5—Some Simple Carlighting Circuits

THERE are three general ways in which modern car lighting systems charge storage batteries:

1. Constant current method.
2. Constant voltage or taper charge.
3. Combination of 1 and 2.

We shall now investigate these three systems in detail.

1. In the constant current system the generator maintains a constant charging current (of a predetermined rate) until the battery is fully charged, the generator voltage then being cut down to, and held at, a point where it is only very slightly higher than the battery voltage. At this point the battery floats on the line (neither charges nor discharges) while the generator still continues to supply current to the lamps or other devices. Since the battery voltage gradually rises as charge proceeds the generator voltage must also rise in order to keep such a difference of voltage between itself and the battery as will cause a constant flow of current of the required number of amperes.

2. In the constant voltage system of charge, the voltage is kept constant throughout the period of charge, that is, if we are charging a 30-volt battery then with a constant voltage system our generator voltage will be 35 volts throughout the period of charge regardless of the current flowing.

Since the battery voltage rises as charge proceeds the current will gradually fall off from a maximum (its highest value) at start of charge to zero at the end of charge. That is, the charging current tapers off.

3. In the combination system the charge is carried on in such a way that the charge is a taper charge but with the modification that the rate of current flow at beginning of charge depends on the state of charge of the battery.

In practically all modern systems an ampere-hour meter is used in conjunction with the storage battery, the ampere-hour meter often figuring directly in the regulation of the generator. An ampere-hour meter is not only a guide to the condition of charge of the battery but it also serves as a check on the operation of the generator, that is, by a comparison of the meter readings for the beginning and end of a trip, we arrive at a conclusion as to whether the generator is operating properly or not.

As the car, containing the axle-light generator, speeds up the armature speeds up also (in most systems) and, as we learned in our study of generators, the voltage increases if the field strength remains constant. Now, as it is important that the voltage remain constant for any degree of battery charge (this value of voltage depending on the method of charge) it is necessary that the system of regulation embody some means of bringing this about. In practice this is accomplished in either of two ways; by making the generator speed constant regardless of car speed or by varying the strength of the field current.

The Stone-Franklin system employs the "belt-slip" method to keep the speed of the generator constant so that when the car speed increases the speed of the armature remains constant because with a tendency to increase in speed the belt slips on the generator pulley, thus preventing the speed of the armature exceeding a certain rate. In practically all other systems the armature speed is variable and the field strength is varied to keep the voltage constant.

In all car lighting systems lamps are connected in parallel with the generator and battery. When the car is at rest the battery supplies the current, but when the car is traveling at a speed greater than a certain set rate — say 12 miles per hour — the generator supplies current to the battery and the lamps.

Now suppose the lamps are 31-volt lamps and the battery voltage is 31, then while the car is at rest the lamps are subjected to their rated voltage, but when the car is in motion the generator voltage is necessarily above that of the battery and the lamps will be subjected to higher than their rated voltage unless some provision is made to keep the voltage across the lamps constant. Thus if a voltage of 35 is required to force normal charging current into the battery the lamps would be subjected to a voltage of 35 which is in excess of 4 volts over their rated voltage. This would be enough to injure the filaments and cause them to be burned out prematurely. As the voltage of the battery increases, that of the generator increases and the lamps would be subjected to a still higher voltage which would cause them to burn out at once.

If the voltage is constant at, say, 35 volts then a fixed resistance may be inserted in the lamp circuit when the car is in motion, but if the voltage is variable as in the constant current or modified taper charge systems, then a variable resistance which depends on the voltage of the lamps must be inserted in the lamp circuit. This is accomplished by means of a lamp regulator or lamp circuit resistance regulator the governing coil of which is connected across the lamp circuit. As the voltage of the generator increases the voltage across the lamp circuit tends to increase thus increasing the "pull' on the coil which in turn automatically inserts more resistance in the circuit until the voltage across the lamps is normal.

The general features incidental to the different methods of regulation will be more readily understood by referring to the following diagrams, Figs. 57, 58, 59, and the accompanying explanation: *A* is the armature of generator, *F* the field of generator, and *FC*, variable resistance connected in series with field coils — this resistance being made up of a series of carbon disks the pressure of which may be varied by lever-arm *E*, thus increasing the resistance (decreasing field current) when the pressure is taken off the carbons, and decreasing the resistance (increasing the field current) when the pressure is applied to the carbons, that is, when carbons are pressed closer together.

LC is the lifting coil which is connected across the armature, that is, in parallel with the armature, at all times.

P is the iron plunger of automatic-switch, which when lifted by action of coil *LC* closes the circuit between battery and generator as *AS—AS* being the automatic switch proper.

RC is the releasing coil the action of which shall be explained later on.

AHM is the ampere-hour meter. Figs. 57 and 59 show the "zero contacts" which are the contact points of a switch that closes an auxiliary operating circuit when the battery is fully charged as will be explained later. The battery is fully charged when the hand of the meter gets to zero; therefore, this type of meter shows the amount of current that has been used out of a battery rather than the amount that still remains. Thus if the hand is at 100 it shows that 100 ampere-hours have been used out of the battery, or in other words the battery must receive 100 ampere-hours charge before it will be fully charged.

B is the storage battery.

SC, Figs. 57 and 59, is the series or current coil connected in series with battery. The amount of "pull" which this coil exerts on plunger E^1 depends on the current flowing into the battery because if the coil had ten turns, and ten amperes are flowing into the battery the "pull" is equal to 10 amperes $\times$ 10 turns = 100 ampere-turns. If 20 amperes are flowing into the battery the pull is equal to 20 amperes $\times$ 10 turns = 200 ampere-turns, and so on.

MC, Figs. 57 and 59, is a modifying coil (inside coil *SC*) which assists coil *SC* in its action on plunger E^1 as the voltage rises. As this coil is connected across the generator circuit its pull is governed by the generator voltage because if the coil has 100 turns and a resistance of 30 ohms, with a voltage of 30, the current in the coils is 30 volts $\div$ 30 ohms = 1 ampere; and the "pull" of the coil is equal to 1 ampere $\times$ 100 turns = 100 ampere-turns. If the voltage becomes 60 then the current through the

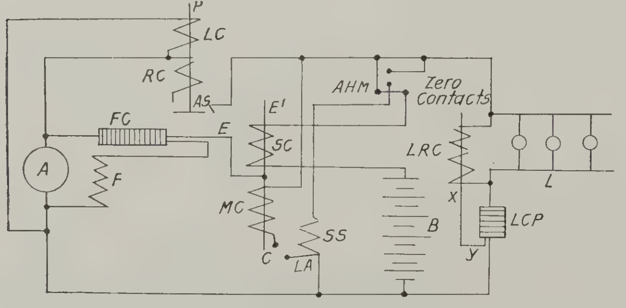


Fig. 57

coils is 60 volts $\div$ 30 ohms = 2 amperes; and the pull of the coil is 2 amperes $\times$ 100 turns = 200 ampere-turns. Thus, it is seen that the "pull" of the coil is governed by the voltage of the circuit. It should be noted that plunger E^1, on which coils *SC* and *MC* act, affects the pressure on carbon pile *FC* by means of lever *E*.

In Fig. 58 *VC* is a voltage coil which works on the same principle as the modifying coil except that it is not used in conjunction with another coil, that is, it acts alone.

In Fig. 59 *R* is a resistance which is short-circuited by means of the zero contacts when the meter hand reaches zero, that is, when the battery is fully charged.

In Fig. 57, *SS* is called a stop-charge relay. It consists of an electromagnetic solenoid with a fixed contact *C*, and a lever arm *LA* which makes contact with *C* when the battery is fully charged thus connecting coil *MC* in circuit. It should be noted that coil *MC* is inactive until stop charge closes.

L is the light circuit. *LCP*, Figs. 57 and 59, is a variable resistance (carbon pile) connected in series between the lamp circuit and that of the generator or battery.

LRC, Figs. 57 and 59, is the lamp regulator coil which is connected across the light circuit and affected by variations in the voltage across the lamps as previously explained, this coil acts in such a way that (by means of plunger *X* and lever *Y*) the pressure on the carbons is varied to keep the voltage across the lamps constant.

Referring to Fig. 57, as the car starts from rest the armature conductors cut across the residual magnetic field

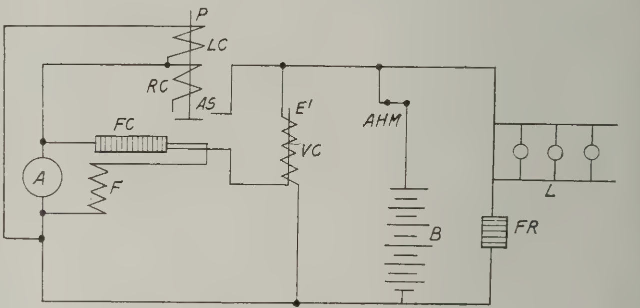


Fig. 58

and generate a voltage. This voltage causes a current flow through *FC* and field coils *F* thus increasing the field strength and causing the voltage to become still higher. Current also flows through coil *LC* and when the voltage has reached a certain point (which is one or two volts above battery voltage) enough current is flowing through *LC* to cause it to lift plunger *P*, thus closing the circuit between battery and generator through coil *RC* which assists *LC* in holding the switch tightly closed. Current then flows from generator through *AHM*; *SC* and *B* back to generator. As the voltage continues to rise the current through the circuit *AHM*, *SC* and *B* naturally increases. This causes *SC* to exert a greater influence on plunger E^1 thus increasing the resistance in the field circuit, which decreases the field current and, consequently, the voltage. This decreases the pull on *SC* and causes the voltage to rise somewhat, which in turn causes *SC* to exert more pull on E^1. These fluctuations take place very rapidly until a balance has been reached between speed, field current and battery current. This will be at a point where, for the speed at any moment, the field current is such that the generator will produce a voltage that will cause a predeterminated rate of current flow through battery *B*.

The voltage necessary to do this is, of course, governed by the voltage and resistance of the battery. Thus, if the battery voltage is 30 and its resistance is 0.1 ohm while its current setting (the rate at which it is to be charged) is 50 amperes, then the voltage necessary to produce 50 amperes flow is 50 amperes $\times$ 0.01 ohm = 5 volts above the voltage of the battery, that is, the generator voltage must be 30 volts + 5 volts = 35 volts.

If it takes a field current of ½ ampere to produce this voltage when the car is running 60 miles per hour, then when the car is running 30 miles per hour the field must be twice as strong to produce the same voltage as it did at 60 miles per hour, or, in other words, the field current

must be 1 ampere. In the same way we find that at 15 miles per hour the field current must be 2 amperes and so on.

The current continues to flow at a rate of 50 amperes until the battery is fully charged. At this point the zero contacts close, completing circuit of coil *SS*, thus closing it to pull up on *LA* closing the circuit of coil *MC* at *C*.

Coil *MC*, which is inside coil *SC*, is so designed that when a balance is obtained between speed and field current (due to action of *MC* on *FC*) the voltage of the generator is cut down to the "floating voltage" of the battery which is 35 volts. From this point onward no current flows into or out of battery *B* and coil *SC* therefore loses

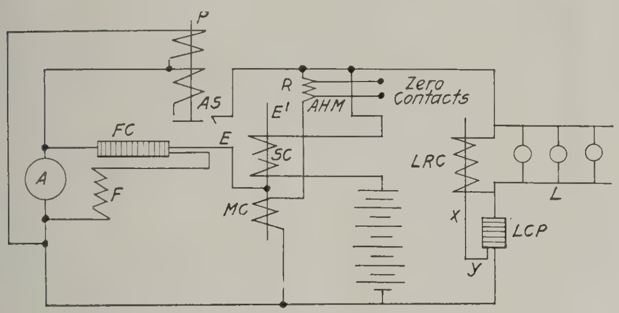


Fig. 59

its power, that is, coil *MC* takes complete charge of the generator.

As the battery charges the voltage of the generator rises, consequently the voltage across the lamps tends to become greater but as the voltage rises the pull of *LRC* increases thus keeping the voltage across the lamps constant. We are now ready to investigate the function of coil *RC*. As the voltage "builds up" the current flows in *LC* in such a way as to establish an *N* pole at the top and an *S* pole at the bottom. Then, as switch *AS* closed the current flowed from *A* through *RC* in such a direction that *RC* also formed an *N* pole at the top and an *S* pole at the bottom (*LC* being inside *RC*), that is *RC* assisted *LC* in holding the switch tightly closed. Now suppose the car to be slowing down for a stop. As the speed decreases the voltage of battery *B* will eventually become higher than that of generator *A* and if the switch *AS* remain closed the battery will tend to drive the generator as a motor, but as the load on the motor would include the weight of the whole train it is readily seen that an excess of current would flow which would blow generator fuse. This would necessitate the application of a new fuse each time the train started up, but switch *AS* does not remain closed because of the following factors:

Since the lower end of *LC* is always positive regardless of whether it is obtaining its current from the battery or the generator, it will always have an *N* pole at the top and an *S* pole at the bottom (this is readily seen by referring to Fig. 57). With current flowing from generator to battery coil *RC* has an *N* pole at the top and an *S* pole at the bottom but when the battery voltage is higher than the generator voltage, current will flow from battery to generator, that is, it will flow through *RC* in the reverse direction and consequently will form an *S* pole at the top and an *N* pole at the bottom. Since one coil is tending to form an *N* pole at the top, and the other an *S* pole at the top, the two coils will "buck" each other, that is one will kill the effect of the other. Therefore, the weight of the plunger will cause it to fall, opening the circuit between generator and battery before the reverse current from battery to generator becomes great enough to blow the generator fuse.

Coil *VC*, Fig. 58, is designed to keep the voltage constant at all times regardless of lamp or battery currents. *FR* is a fixed resistance in series with the lamp circuit. Since the voltage is constant at all times, a variable resistance is not needed as in the variable voltage systems. With constant voltage the battery current tapers off as the battery voltage rises because the generator voltage does not rise in order to compensate for the rise in battery voltage as it did in the variable voltage (constant current) systems, Fig. 57.

Fig. 59 illustrates the modified taper charge system. Resistance *R* which is connected in series with *MC* limits the activity of *MC* to a certain extent until the battery is fully charged. If the battery voltage is low at beginning of charge, the activity of *MC* is small, and therefore *SC* practically controls the system. As the battery voltage rises the activity of *MC* becomes greater thus relieving *SC* of some of its authority. Thus the current tapers off until the battery is fully charged at which time the zero contacts close causing *R* to be short-circuited and thus giving coil *MC* complete charge of the system. The battery "floats" with *MC* in charge, as explained in connection with Fig. 57.

It should be noted that in the systems just described, the battery current is independent of the light current, that is, if the battery is taking 40 amperes and the lights 20 amperes, then the generator is putting out 60 amperes; if the lights are turned off the generator is putting out 40 amperes. If the lights are taking 30 amperes the generator is putting out 70 amperes and so on. Systems of this kind in which the generator is regulated by means of the battery current are called battery-current-regulation systems.

There is a means of making these systems generator-current-regulation systems but the disadvantages greatly outnumber the advantages. In such systems the current output of the generator is constant while the battery current is variable, depending on the light current, thus, if the generator is set for an output of 60 amperes with no lights on, the battery will take 60 amperes; with the lights taking 10 amperes the battery will receive 50 amperes; with the lights taking 40 amperes the battery will receive 20 amperes; with the lights taking 60 amperes the battery will receive no current, and so on.

* * * *

This concludes the series of articles on the subject of "Basic Principles for the Electrical Workman." We are expecting to publish additional articles from time to time by Mr. Graham, which will be of much practical benefit to electrical men. Among these will be a series on the subject of elementary alternating current theory.—Ed.

If the aim of a life be right, it cannot in detail be much amiss.

Let a man get the idea that he is being wronged, or that everything is against him, and he cuts his earning capacity right in two.

It takes just six hours to convert a growing forest tree into a paper printed and sold on the streets.

Automatic Train Control Developments

Increasing Activities Are Manifested by the Appearance of Many New and Improved Devices

Shadle Automatic Train Signal Stop

A GENERAL description of the Shadle automatic train signal and stop appeared on page 149 of the *Railway Electrical Engineer* for May, 1922. Additional information pertaining to this device and tests recently run are included in this issue. A brief performance record is also given.

Performance Record

On October 5, 1917, the first official test of the Shadle system, equipped with the emergency stop was held at Indianapolis, Ind., on the Cincinnati, Indianapolis & Western. On May 31, 1918, the second official test was made, the emergency stop, in the meanwhile, having been discarded. On July 11, 1919, the third official test was held in the presence of the members of the Automatic Train Control Committee of the United States Railroad Administration. On September 22, 1920, the fourth public test was held before a representative gathering of railroad men. All these tests were conducted on passenger equipment. In the meantime passenger engine No. 106 on the C. I. & W. was equipped with the Shadle device and used in daily service between Indianapolis, Ind., and Cincinnati, Ohio, over 15 miles of ramp equipped territory near Indianapolis.

It was early pointed out that the braking of a passenger train was comparatively simple when compared with the braking of a heavy freight, so on April 12, 1922, complete train control apparatus was installed on C. I. & W. Mikado engine No. 404. Since that date, the equipment has been in daily freight service.

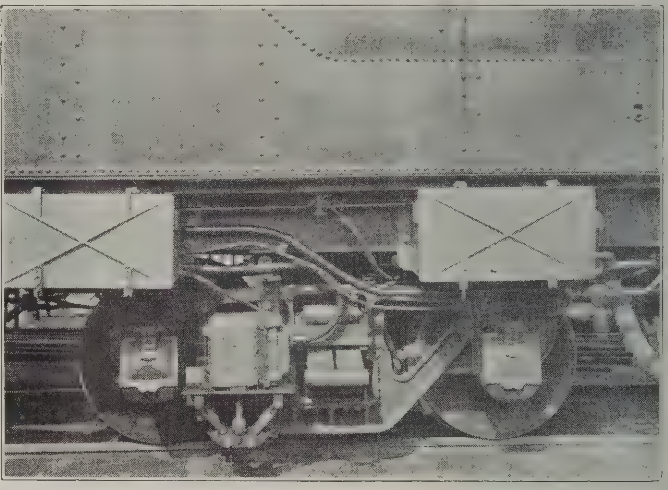
Roadside Equipment

The Shadle system is of the intermittent contact type, and requires a ramp 60 ft. long with a 6-ft. approach at either end, giving a 48-ft. contact for the shoe. The ramps are located in advance of the roadside signals, the distance being governed by traffic conditions. Each ramp is supplied with a source of electrical energy from the same battery that furnishes energy for operating the roadside signal. The supply circuit for the ramp is controlled through the track relay of the block in advance, and also through the control relay for single track signaling. These relays are now part of the present automatic roadside signals, and the ramp and the train signal become, therefore, a part of this system and work in conjunction with it. The control wire for a single track system is so attached to the ramp that the destruction of the ramp or any portion thereof will open the control circuit; this will indicate two blocks in the rear, setting the second block at caution, and the first block in advance at stop, thus giving the engineman a two-block indication. The ramps at these signals will also indicate properly.

The ramp rails are located 23 in. from the center of the ramp to the gage side of the running rail, and are supported on cast steel brackets. These ramps are made of ⅜-in. iron with a 4-in. leg, and a 4-in. base, and are insulated with ⅛-in. fibre between the ramp and the steel bracket. About one foot of the end of the ramp is turned down, reaching within an inch or so of the top of the tie. There are 10 brackets to a ramp, and sawed ties are put down for supporting the brackets and ramp rail. The brackets are fastened by two lag screws. None of the ramps shows any wear on the contact surface after three years' service.

Locomotive Equipment

A contact shoe is fastened to the forward tender truck frame. Two iron boxes are located on the tender; one is used for carrying the electro-magnets and circuit controllers, and the other for the 75 a.h., Edison storage battery, which is in two units of five cells each. The voltage used is 13.5 volts. The electro-pneumatic maintaining air valve for maintaining the air brake system in the normal relation is also located in the same container; and a cast iron body, heavy type Klaxon horn is used for the audible signal. The above equipment is located on the tender of the locomotive, where it does not receive the vibration that it otherwise would receive if it were located on the locomotive proper. In the locomotive cab there are two signal lights, a green light for a clear block, and a yellow light for a caution and occupied block. These two lamps are in separate containers, and are provided with 4-in. standard signal lenses in waterproof containers. The "permissive proceed" or release switch is also in the cab, and located conveniently near the engineman's automatic brake valve, and within easy reach. Under the cab, and located in the piping system, is one equalizing reservoir release valve, one feed pipe cut out valve and one automatic graduated service brake valve.



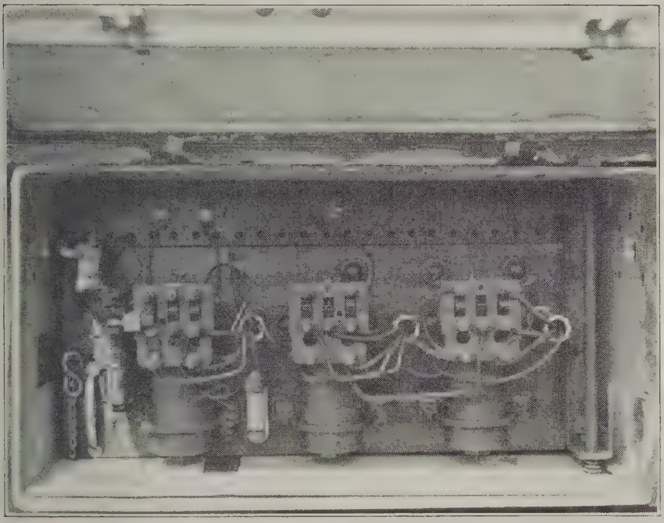
Shoe and the Battery and Relay Boxes on Tender

On the pilot of the locomotive, about in line with the front end of the smoke box, properly protected, is located the Tachometer generator of the speed control portion of the Shadle device. This generator is in a waterproof

casing, and is driven by a drive direct from the front pony truck wheel. The apparatus listed above constitutes the entire equipment on the locomotive or along the roadside for automatic cab signals, automatic graduated brake and release and automatic train speed control.

On January 14, 1923, the graduated service brake and release apparatus alone was installed on C. I. & W. Mikado engine No. 403. A knife switch, located in the locomotive cab, is used to energize or de-energize the electro-pneumatic maintaining air valve to cause an application of the brakes or their release. Long runs are being made with this locomotive and all brake applications and releases are being made by merely closing or opening this switch. It has been noticed that brake application and releases made through the train control air brake apparatus are smoother than are those made by normal hand operation. It is claimed for the device that triple valves which tend to "dynamite" in hand operation, fail to "dynamite" when operated through the train control mechanism, and that the train control mechanism will release the brakes without shock on heavy freight trains at a speed of three miles an hour.

It is stated that since April 12, 1922, the maintenance cost of the equipment on engine 404 has been $4.55 and that so far there has been no maintenance charged against the air brake equipment on engine 403. This apparatus, however, has only been in operation since January 14, 1923. It is also stated that no maintenance work has been



Electro-Magnets and Circuit Controllers

necessary on the 15 miles of ramps which have been installed for a period of three years.

Freight Train Service Tests

On December 8, 1922, a committee of Baltimore & Ohio officers observed a number of tests on a freight train, the details of which are given below.

C. I. & W. Mikado locomotive 404, completely equipped with the train control apparatus, was used in the test. Train No. 65, with 2,218 tons and having 48 cars, was used in the test. There were eight 80-ton coal cars on the rear end. The automatic graduated brake was set for a 22-lb. reduction; the speed control was set for a speed of 18 mi. an hour. The weather was clear and warm.

The engine left Moorefield yard under speed control with a yellow and green cab signal. While running through the yard over switches at 18 m.p.h. the engine received a brake application. The brakes were released at 15 m.p.h. After the engine coupled onto its train at State street yard, and before passing over the first ramp, the train exceeded the speed control limit and received a 10-lb. reduction. The brakes were released smoothly at 12 m.p.h.

The first block encountered was yellow, and a yellow cab signal burned in the cab. The speed was 12 m.p.h. and the engineman pushed the release switch forestalling the brake application. The train then proceeded under speed control with a yellow and green cab signal indication in the cab.

The second block encountered was also yellow. The yellow cab signal indicated properly. The speed of the train was 5 m.p.h. and the engineman pushed the release switch forestalling the brake application.

The third block was yellow and a yellow cab signal was received. Speed of the train, 15 m.p.h. The engineman did not push the release switch and the train came to a full easy stop in a distance of about 800 ft. The engineman released and proceeded with a yellow and green cab signal under speed control.

The fourth block was yellow, the yellow cab signal indicating on the engine. Speed, 18 m.p.h. A 20-lb. brake pipe graduated reduction was made. When the speed of the train was reduced to 5 m.p.h. the release switch was pushed and the brakes released properly on the engine and the train without shock or jar. The train proceeded through the block under speed control. When the train attained a speed of 19-20 m.p.h. the speed control apparatus operated, making a 15-lb. brake pipe reduction. When the speed was reduced to 12 m.p.h. the release switch was pushed and the brakes released properly. The train then proceeded under speed control.

The fifth block was also yellow, and the yellow cab signal indicated on the engine. The speed of the train was 18 m.p.h. A 20-lb. reduction was made and the train came to a full stop in a distance of 1,000 ft. without jar.

Further tests of the train control device in freight service were made on December 13, 1922, which were witnessed by some officers of the Illinois Central. The same engine was used for this test as for the test described above. A report covering the test follows:

Train No. 91, with 1,795 tons and having 39 cars, consisting of 35 loads and 4 empties was used for this test. The automatic graduated brake was set for a 22-lb. reduction; the speed control apparatus was set to function at 28 m.p.h. The weather was clear and warm.

The train left Moorefield yard at 11.20 a.m., with a yellow and green cab signal indication on the engine and under speed control.

The first block was clear and the green cab signal showed on the engine. Speed, 18 m.p.h.

The second block was clear; a green cab signal was received on the engine. Speed, 10 m.p.h.

The third block was clear; a green cab signal was received on the engine. Speed, 15 m.p.h.

The fourth block was clear; a green cab signal was received on the engine. Speed, 25 m.p.h.

The fifth block was at caution and the yellow cab signal indicated on the engine. Speed, 30 m.p.h. A 22-lb. reduction took place and the train came to an easy stop in a distance of 2,000 ft. with no jar or shock or run in or out of slack. The train then proceeded through the block

under speed control with a yellow and green cab signal indication.

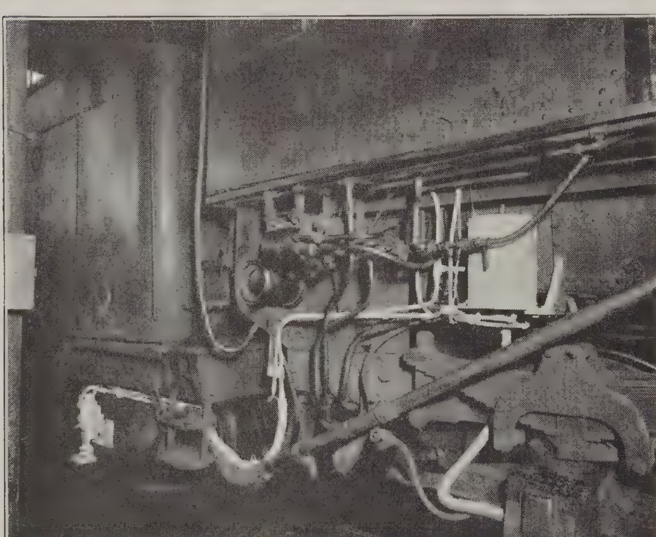
The sixth block was clear and a green cab signal was received. Speed, 20 m.p.h.

The seventh block was at caution and a yellow cab signal was received, the speed of the train being 25 m.p.h. The apparatus made a 20-lb. reduction, and the brakes were held on the engine and train until a speed of 3 m.p.h. was reached, when the release switch was pushed. The brakes then released without any perceptible jar or shock to the engine, train or lading. The train then proceeded under speed control with a yellow and green cab signal indication.

The eighth block was at caution and a yellow cab signal was received. The train was moving at about 5 m.p.h. at the time the contact shoe on the locomotive made contact with the ramp. After a 10-lb. reduction had been made by the apparatus the handle of the automatic brake valve was repeatedly thrown in the release position in order to see whether the brake application could be forestalled, but it was found that it could not be. At a speed of 3 m.p.h. the release switch was pushed and the brakes released smoothly, notwithstanding the fact that the middle of the train was on the top of a hill or knoll, while the caboose was on the up grade and the locomotive was on the down grade. No run in or run out of slack occurred. The train then proceeded under a yellow and green cab signal indication through the block.

The Miller Automatic Train Control

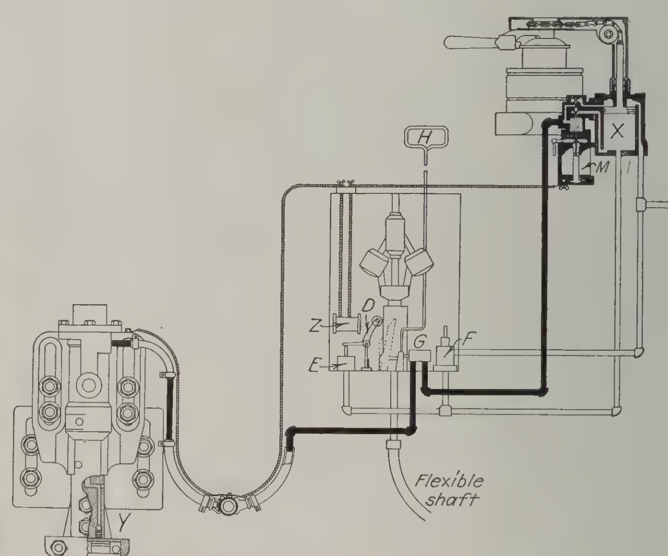
THE Miller Train Control Corporation's governor type of speed control, designed to be used as an adjunct to its train control system, is of the air controlled rather than the electrically controlled type. The speed controller is designed as an adjunct to the automatic stop feature of the device so that should it be accidentally broken or otherwise be put out of commission it can be cut out and the train proceed under the protection of the automatic stop. The positive stop attachment to be used with this company's automatic stop, when speed control is not used, consists of a small automatic air valve. The addition of the speed control apparatus and the positive stop valve does not change the fundamental principles of this company's train control as described in detail on page 125 of the *Railway Electrical Engineer* for April, 1922. The following information concerning the speed control equipment and release is supplemental to the former article.



Speed Control and Shoe Mounted on Engine

A Cam Type of Speed Control

This speed control consists of a set of cams in a housing which is raised and lowered by a fly ball governor. These cams function at different speeds to open an air valve controlling the air brake system. The speed control equipment consists of a suitable circular case in which is mounted the fly ball governor, cams and air valves. The governor is driven from a flexible shaft or other suitable means from the trailer truck or a driver wheel of the locomotive. The instrument is so designed that centrifugal force of the governor lifts a sliding sleeve or cam housing self-contained on the governor shaft. On this sleeve is a mounted cam. By proper adjustment,



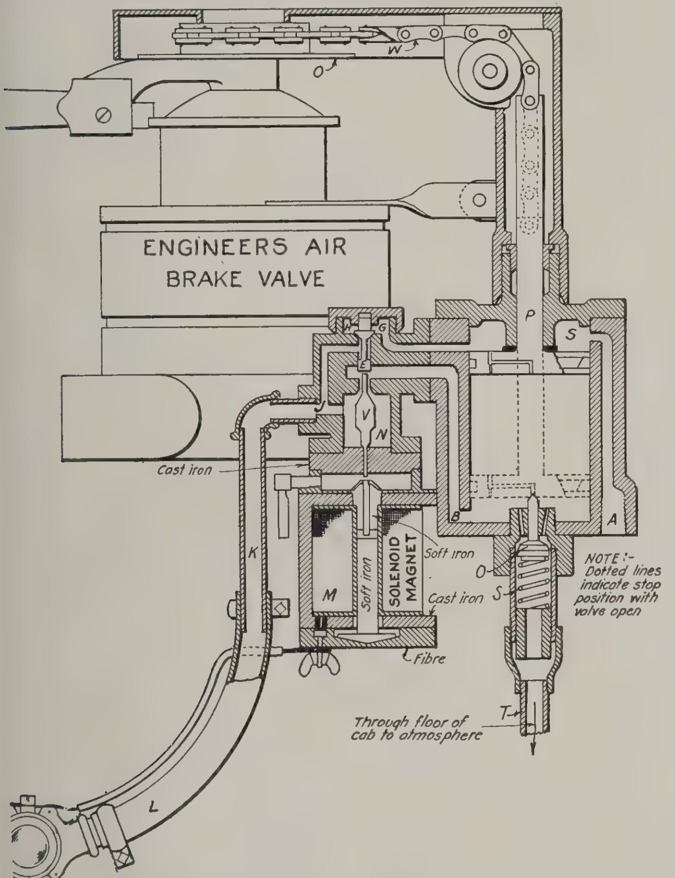
Schematic Diagram Including the Shoe, Speed Control and Control Valve and Operating Cylinder

this cam can be set for a maximum speed so that when the locomotive exceeds that speed, the cam is brought into play under a roller on a bell crank which opens to atmosphere a small valve. This valve is connected with the pipe that leads to the bottom part of the control cylinder. When this valve is open, it causes a reduction of air in the bottom of the control cylinder, the same as if the shoe had been lifted in passing over a ramp, thereby operating the engineman's air brake handle to make a service application of the brakes.

As soon as the speed of the train has been retarded below the prescribed limit, the cam housing and cams, in the speed control device, will drop below the roller on the bell crank, then the air valve at the end of the pipe in the speed control is closed, pressure immediately builds

up at the bottom of the control piston, the piston is restored and the engineman can release his brakes.

If the shoe engages a de-energized or "stop" ramp, this causes a reduction of air in the usual manner on the bottom of the control piston, bringing the engineman's air brake valve handle to a service application of the brakes. A reduction of air also takes place in the pipe between the control instrument and the governor, which causes the control cylinder in the governor to drop down and bring the medium speed cam into play, thus holding the small air valve in the governor open, and consequently keeping the brakes applied or in a service position until such time as the train has reduced speed to say 25 m.p.h. This reduction in speed causes a lowering of the sleeve containing the cams on the governor shaft,



Application of the Automatic Air Valve to Release on a Positive Stop

which drops the medium speed cam to the position for this speed, and as long as the locomotive travels under this prescribed or arbitrary speed, the engineman can release his brakes and handle the train in the usual manner. But should he attempt to exceed the arbitrary speed the cam again will come into play, opening the small air valve in the governor, again causing a reduction on the bottom of the control piston and apply the brakes.

The governor stays in this position until the shoe engages a clear or energized ramp, in which case a magnet in the speed control governor unlatches a catch. The medium speed cam on the sliding sleeve is then restored to normal, and the engineman can then run at speed up to the maximum speed as may be predetermined by the maximum speed cam, which is part of the sleeve. The magnet is connected in series with the control instrument.

Also incorporated in this device is a low speed function, which is brought into play manually by the engineman who may, if alert, and by reducing the speed to a predetermined amount of say 10 m.p.h., perform an act which will forestall the automatic action of the control at a dead or stop ramp. In so doing he also sets out in the governor a low speed cam, which will limit the speed to this rate. This cam functions under the roller attached to the arm and valve the same as it operates under the other cams. The low speed cam remains locked in this position until an energized ramp is engaged, the current flowing through the magnet releasing it.

One advantage claimed for the pneumatic governor is that it gives the engineman an audible warning in advance of its making a stop application. This not only calls the attention of the engineman to the speed of his train in accordance with the adjustment of the governor, but gives him enough advance warning that he can control the speed of the train if he is alert and forestalls the action of the governor by bringing the speed of the train under the prescribed rate as set up by the governor. When the brakes are applied by the speed control or the automatic stop feature the train will be brought to a stop, unless the proper release is made by the engineman.

Operation of the Positive Stop

The train control system in service at present on the Chicago & Eastern Illinois has a permissive feature whereby the engineman, if alert, may push a rod on the bottom of the control valve which will permit him to pass over a stop ramp without an application of the brakes. This feature, as contained in paragraph "B" of the specifications drawn up by the Bureau of Safety of the Interstate Commerce Commission and the Joint Committee on Automatic Train Control of the American Railway Association, was eliminated in the Commission's order to the railroads. As the order now stands, providing speed control is not used, it is necessary that a train be brought to a full stop by an automatic application of the brakes. In order to insure this operation, it is required that the engineman get on the ground to operate the release. The Miller Train Control Corporation meets this specification by the use of an automatic air valve.

The pneumatic style of release consists of a small valve *O* inserted into the bottom of the control cylinder. This valve is normally held closed by proper spring tension *S* and is opened only by the action of the piston coming down in the cylinder, when a "stop" indication is received at a ramp. As the piston bears against the valve it causes a flow of air direct from the chamber *B* to atmosphere through the pipe *T* and this pipe may be carried to any convenient place outside of the cab.

The result is that piston *P* is locked down pneumatically until such time as the end of pipe *T* is closed manually, for example, by the engineman placing his finger over the end of the pipe. In this case the piston *P* and valve *O* will resume their normal position.

At the end of the day every man knows whether or not he has done a fair day's work.

What is required of a man who would succeed is very simple: 1. Willingness to work; 2. Dependability; 3. Temperance; 4. Politeness; 5. Willingness to learn as he goes along, and to get his learning on straight.

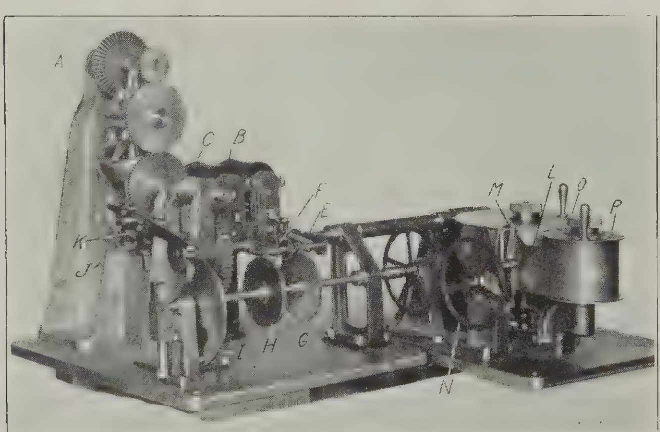
The Simmen System of Speed Control and Train Dispatching

SINCE the article describing the Simmen System was published in the April, 1922, issue of the *Railway Electrical Engineer,* page 121, considerable development work has been done. Several speed control machines have been built and put through extensive shop tests. The photograph shows a speed control apparatus designed to enforce the allowable speed for two distinct purposes. One part of the apparatus enforces maximum, caution and minimum speeds necessary on account of temporary hazards and the other part of the machine enforces speed reductions to any desirable speed needed because of permanent hazards.

Speed Control for Temporary Hazards

The part that enforces speeds due to temporary hazards is based on the same principle as explained in the April, 1922, issue of the *Railway Electrical Engineer.* In the photgraph a shaft at *A* is connected by a flexible shaft to one of the axles of the locomotive, and it is through this shaft that the various parts of the apparatus receive motion. Electro-magnet *B* is the maximum speed magnet and electro-magnet *C* is the caution speed magnet.

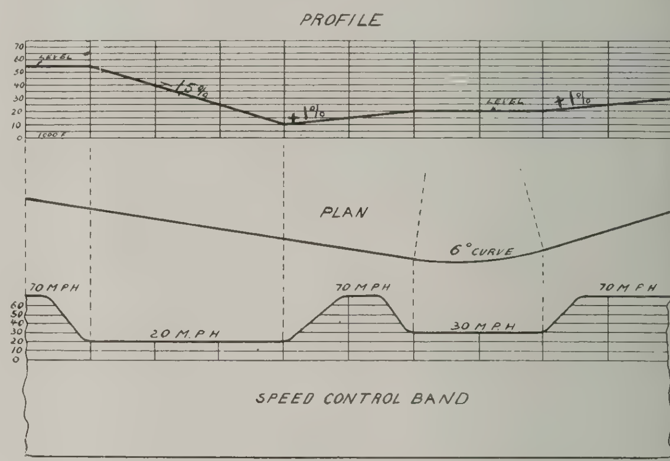
When the locomotive is passing a ramp rail which is positively energized, both magnets *B* and *C* are energized and both gear trains *E* and *F* are out of mesh with gears *G* and *H*. An idea of the relative size of the apparatus may be gained from gears *G* and *H* which are 3 in. in diameter. When this occurs, the cam *I* is in its maximum speed position as shown in the photograph. When the locomotive is passing a ramp which is negatively energized, magnet *B* becomes de-energized and gear train *E* engages with mutilated gear *G* and gradually turns the cam to the caution speed position. Gear *G* is so mutilated that when the cam has reached the caution speed position, the mutilation in the gear prevents any further rotation of the cam.



Speed Control Apparatus Controls Three Speeds

When the locomotive is passing a ramp which is de-energized, magnet *C* becomes de-energized and gear train *F* engages with gear *H* and the cam is gradually turned to the minimum speed position. There is also a mutilation on gear *H* so that when the cam has arrived at the minimum speed position, no further motion is given to the cam. Assuming now that after a train has passed a de-energized ramp, the next ramp encountered is negatively energized, then magnet *C* becomes energized, gear train *F* is lifted out of mesh with gear *H* and the cam will rotate back to the caution speed position, but if the next ramp encountered is positively energized, both magnets *B* and *C* will be energized and the cam will rotate back to the maximum speed position.

The contact shown at *J* is the whistle contact, and when a train gets to within two miles of its permissive speed, this contact is broken and a whistle is blown. If the engineer does not heed this whistle by slowing his train down and when the actual speed of the train reaches the actual permissive speed, contact *K* is broken which de-energizes an electrically controlled air valve resulting in the automatic application of the brakes. By a study of the article in the April, 1922, issue of the *Railway Electrical Engineer* it will be understood that as the cam turns from a maximum or a caution speed to lower permissible speed, it is so turned in accordance with a predetermined speed reduction curve, that is, the cam turns in accordance with the distance travelled by the train. Without such a speed reduction curve embodied in the apparatus, a change from a maximum to a caution speed, or from a caution to a minimum speed would be almost instantaneous and would not give the engineman himself an opportunity to reduce the speed of the train.



A Section of Speed Profile Band

Speed Control for Permanent Hazards

The part of the apparatus enforcing various maximum speeds (even when the blocks ahead are clear) due to permanent hazards is also driven from the locomotive axle, but no electrical or mechanical connection between the trackway and this part is necessary. A metallic band *L* is cut out at its upper edge representing a profile of the various permissible speeds along the track. A small roller *M* rides on the top edge of the metallic band and its up and down motion gives motion to gear train *N*. Gear train *N* gives motion to the same shaft to which cam *I* is attached. The band is rolled up on cylinders *O* and *P* and cylinder *O* through proper gearing receives motion from the locomotive axle.

As the locomotive proceeds over the road, the metallic band *I* moves in accordance with the distance traveled. The scale of motion adopted in the apparatus shown in the photograph is 1 in. per mi. It is evident that the profile of permissible speeds as embodied in the metallic

band over a passenger locomotive division for an east or north bound train is different than it is for a west or south bound train and in the apparatus shown in the photograph, this point has been taken care of by making the band long enough for both an east bound and a west bound trip.

The diagram illustrates how the speed profile of the metallic band is arrived at. In the upper part of the sketch is shown a profile of the grade of a section of track. In the middle part a single heavy line represents the alinement in sketch form of the track and the lower part shows the speed profile of the metallic band. It will be noted that the profile of grades shows a descending grade for 3,000 ft. of 1.5 per cent. It is obvious that a maximum speed down this grade is not permissible and it is assumed that the permissible maximum speed should be 20 mi. an hr. Accordingly the metallic band has been cut out in 20 mi. an hr. as shown. Again the track alinement shows a 6 degree curve for 2,000 ft. and here it is assumed that the permissible maximum speed should be 30 mi. an hr. Accordingly the metallic band has been cut out to 30 mi. an hr. If the train is running within 2 miles of the speed the metallic band dictates, the whistle is blown and if the engineman does not heed this whistle, but allows the actual speed of the train to become as high or higher than the band dictates, the air brakes are automatically applied. Of course, with this apparatus, speed restrictions for other purposes than grades and curves can be similarly enforced, such as for slow track, bridges and viaducts or dangerous highway crossings.

Union Switch & Signal Co.'s Automatic Train Control

During the past summer and fall the Pennsylvania has been installing the Union Switch & Signal Company's system on the Lewiston branch and it is expected that this installation will be completed about the middle of April. No track circuit signaling was in service on this division so that the signaling system in connection with the train control had to be installed. The installation will demonstrate what degree of facilities of operation may be obtained under the Union Switch & Signal Company's inductive continuous train control system on both single track and double track.

A contract has also been awarded the Union Switch & Signal Company by the Atchison, Topeka & Santa Fe covering the installation on the main line between Ft. Madison, Iowa, and Chillicothe, Ill., of approximately 101 miles of double track, in which each track will be equipped for both normal and reverse running. This installation involves equipping approximately 125 engines. In addition to the above, it is understood that the Union Switch & Signal Company has contracts for installations on other roads which will include both steam and alternating current propulsion and the installation of the train control system superimposed on d. c. track circuits.

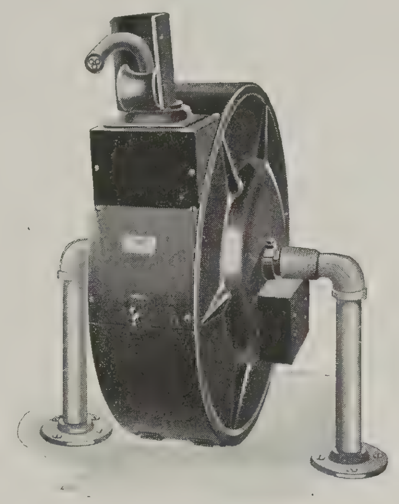
Seven hundred farmers and farm laborers recently arrived on a single steamer for Ontario and places in Canada.

A special menu for children is the latest innovation on the dining cars of the Northern Pacific. It is illustrated with pictures designed to interest children.

Heavy-Duty Extension Cable Reel

The Heavy-Duty Reelite, recently developed by the Appleton Electric Company, Chicago, is a specially built, self-contained device for paying out and automatically retrieving electric conductors for power and light. It is especially adapted for machinery requiring a varying length of cable. This will permit operation of the machinery at any distance within the radius equal to the length of cable contained in the reel.

Among the machines with which this device can be used may be listed cranes, dredges, mining machinery, magnets, electric motor buckets, etc. Also it can be used



The Heavy Duty Reelite

extensively in foundries, forges, machine and car shops, and electric welding shops.

The device is furnished without brackets but with 1-in. male-threaded hubs so that it is easily adaptable to any requirement. The power cable is connected to it by means of heavy brushes operating on commutators. The wire is connected to the commutators, eliminating wear and tear on connectors and always insuring a perfect contact.

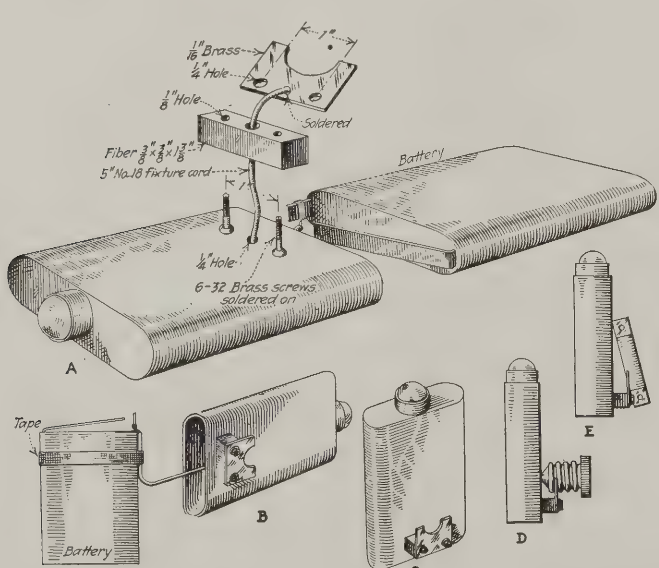
The heavy-duty reelite can be furnished in various widths, all of the same diameter and with two or three wire commutators, as may be required. In ordering it is necessary to specify the amperage and voltage so that proper commutators and brushes will be installed.

On the West Railway, Norway

Handy Fuse Tester

In the sketches following is shown a method for converting a pocket flashlight into a fuse tester, which will be found very convenient for the man who frequently has occasion to test fuses. It was first described in the Industrial Engineer and was really designed for use in the tool kit of a factory electrician. It is, however, such a unique and compact arrangement that it will no doubt find a place among the tools of many electrical men on the railroads as well. It can be carried in the pocket, and the alteration does not interfere with its operation as a flashlight or the action of the push-button switch.

The device is made of a small, flat, nickel-plated pocket flashlight. A ¼-in. hole is drilled in the metal case on the center of one side, about ¼-in. from the bottom rim, as indicated. Two flat-head 6/32 screws ½-in. long are soldered to the case in line with the ¼-in. hole and about



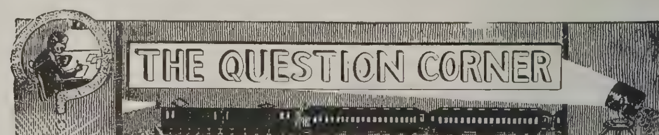
Both Cartridge and Plug Fuses May Be Easily Tested Without Interfering with the Flashlight Feature

1-in. apart as shown. Next a piece of 1/16-in. brass, 1⅜-in. square, is cut with a circular notch. Two ¼-in. holes are then drilled in this brass an inch apart to fit the two screws soldered on the case. Two ⅛-in. and one ¼-in. holes are drilled in a piece of fiber ⅜-in. by ⅜-in. by 1⅜-in. These holes are spaced to fit over the two screws and opening as shown at *A*.

One end of a piece of No. 18 fixture wire about 5-in. long is looped around the short battery terminal as shown at *B*, the insulation of the wire being retained close up to this loop. Before assembling it is good practice to file off sharp edges on the ¼-in. hole in the case to prevent cutting the insulation on the fixture wire.

The testing device is assembled as follows: After putting the loop over the battery terminal, pass the other end of the wire through the hole in the case from the inside toward the outside, through the middle of the fiber block and solder it to the brass piece as shown at *A*. Next the fiber and then the brass piece are slipped over the screws, two fiber washers are added and tightened by two 6/32 nuts. The fiber washers fit into and over the ¼-in. opening in the brass plate and are used to insulate the screws and the nuts. After the nuts are screwed down tightly the protruding ends of the screws are cut off and the rough edges filed smooth. The battery is then wrapped with one thickness of friction tape, as in *B*, to keep the fixture wire in place as well as to insure a good connection and to prevent the loop from interfering with the button switch.

The battery is then inserted in the usual way. The method of testing a plug fuse is shown at *D*, and the method of testing a cartridge fuse at *E*. If the fuse is good, the lamp lights. Care must be taken when assembling that the screws on the case do not come in contact with the brass piece. Also, it cannot be carried in the pocket or tool box with loose pieces of metal which might accidentally close the circuit and thus drain the battery.



Answers to Questions

1. I have several different makes of batteries of the same voltage and ampere-hour rating, some of these are lead and some Edison. I would like to operate same in parallel. What would be the result? Let us hear from some of the car lighting men.—E. I.

2. In referring to the Railway Electrical Engineer, March number, Question Corner, page 90, what is the d. c. voltage after current goes through the lamp bank and four jar electrolytic rectifier?

3. Could more than one battery be charged at one time?

4. Could the ampere charging rate be measured by an ammeter placed in one side of the line after leaving the jars?

5. Where can I obtain a good book on ignition work on automobiles and also a practical electrician's handbook

dealing in motors, compensators, starters, relay coils and in fact all connections?—T. C. C.

Will Lead Cells Work In Parallel with Edison Cells?

1. My experience has been that it is next to impossible to get two sets of the same type and size of batteries to operate satisfactorily in multiple, and as the Edison and lead batteries have entirely different characteristics, it would not be advisable to use them connected in multiple. —C. W. T. S.

In answer to the question concerning the parallel operation of Edison and lead storage batteries which appeared in the April issue of the *Railway Electrical Engineer,* I submit the following information:

Parallel operation of storage batteries is not a very successful method and should be resorted to only when the cells available are not of sufficient capacity to furnish the required number of ampere-hours.

In an emergency this method of connecting batteries may furnish a means of meeting the situation for temporary relief, but will not prove satisfactory as a permanent job. Again, one may have on hand a number of good cells but of lower capacity than required for the work at hand and desire to get some useful service rather than scrap them at once. In either of the above cases, parallel operation may be used. As a practical maintenance proposition, however, it is always best to use cells of the proper capacity and operate them in series both on charge and discharge.

Assuming that the questioner is considering the operation of his available cells in parallel with a view to getting some service from cells which would otherwise be of no use, such operation may be of value. If he has enough lead cells to give him the required voltage in each series and all cells are of the same ampere-hour capacity, fairly successful results may be had. He will have to watch carefully to prevent them getting out of step with each other, due to variation in charge and discharge rates. This tendency arises because of the practical impossibility of producing cells which are alike in all respects. The sets will vary somewhat in capacity, charge and discharge voltage, resistance of connectors, resistance at connecting points, variation in operating characteristics of plates of different make and age of cells. Each of the above contributes its bit toward putting the sets out of step with each other over a period of time.

One may keep the sets fairly in step if it is possible to give them individual treatment at frequent intervals so as to compensate for the adverse effect of the variable factors. Tests will usually show that one set is more fully charged than the other, and the only remedy lies in the individual charging of the low set to again put it in step. The net result is a lot of extra work and some expense, the cells sooner or later reaching a condition where the operation is very unsatisfactory.

Edison cells operate in parallel somewhat better, due to the fact that they are all made by one process; the cells operate at a more uniform voltage than would be the case with lead cells where various makes are mixed together, but even so, the tendnecy to get out of step is apparent, due to the other variables as previously mentioned.

Parallel operation of a lead set and an Edison becomes impossible, due to the widely variable characteristics of the two types. Curiosity on this point led to a test to determine just how they would operate.

Two sets, one of 16 lead cells (all of one make), one of 25 cells of Edison, were used. Cells were of approximately 300 ampere-hour capacity, and both sets were charged separately before the test. Each set had been in service, but were just off the overhauling bench and ready for service. The test results are given in the table below. One may draw his own conclusions as to the undesirability of such operation, particularly in case the sets were not worked over a full cycle of charge and discharge.

DISCHARGE TEST—DISCHARGE RATE 70 AMPERES

	Voltage		Amperes		Ampere-hours	
Time	Lead	Edison	Lead	Edison	Lead	Edison
Start	31¼	32	35	36	..	..
1 hr..........	31	31	37	32	36	34
2 hr..........	31	31	42	29	76	65
3 hr..........	30½	30¼	43	27	119	92
4 hr..........	30½	30¼	43	27	162	119
5 hr..........	30	29½	50	18	208	142
6 hr..........	29	29	45	21	256	162
7 hr..........	28½	28½	40	26	298	185
7½ hr........	27½	28½	28	37	313	198
CHARGED IMMEDIATELY AFTER DISCHARGE. RATE 90 AMPERES, APPROX.						
Start	36	36¼	67	18	..	..
1 hr..........	36	36¼	78	13	73	15
2 hr..........	37½	38	78	13	151	28
3 hr..........	39	39	73	18	224	46
4 hr..........	39	39¼	55	33	279	79
5 hr..........	42	42	40	55	319	134
6 hr..........	42	42	45	45	364	179

G. W. W.

Features of Electrolytic Rectifier

2. The d. c. voltage of the electrolytic rectifier operating on 110-volt alternating current circuit is approximately 70 volts.

3. The number of batteries that can be charged at one time would, of course, depend upon the number of cells in the battery. In other words, the counter e. m. f. of the cells would necessarily have to be less than the available direct current e. m. f. of the charging apparatus.

4. Yes. An ammeter can be inserted in the line between the rectifier and the batteries and would read the same as in any direct current circuit.

Practical Handbooks

5. The following list of books will doubtless meet your requirements:

American Electricians' Handbook. $4.00. McGraw-Hill Book Co., 370 7th avenue, New York, N. Y.

Automotive Ignition Systems. $2.50. McGraw-Hill Book Co., 370 7th avenue, New York, N. Y.

Automobile Ignition. $2.00. F. J. Drake Publishing Co., 1006 South Michigan avenue, Chicago, Ill.

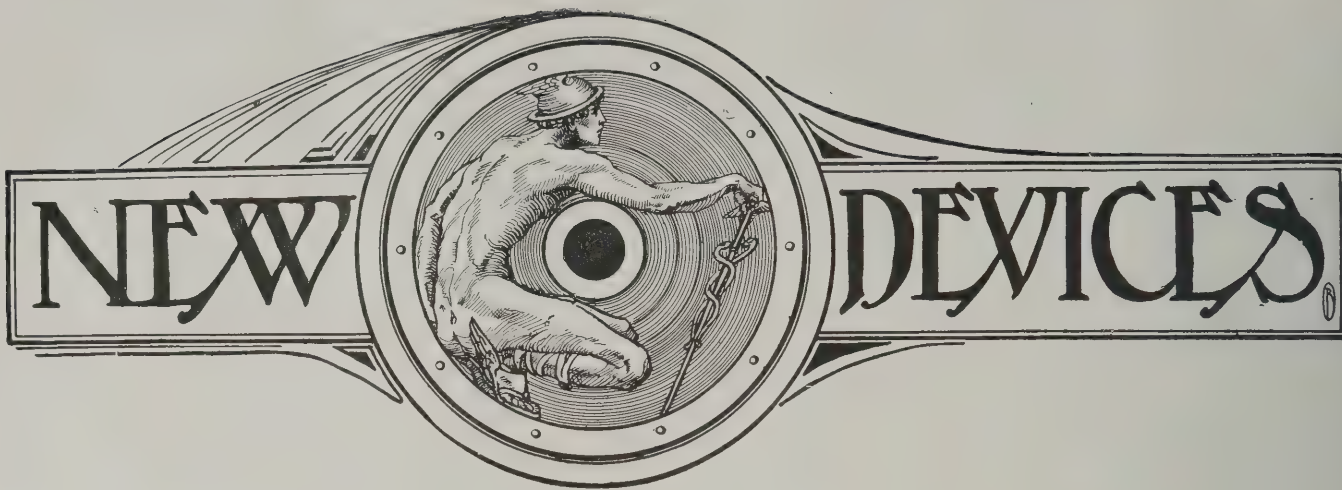
Hallock's Starting and Lighting Systems of Automobiles. $1.00. American Automobile Digest, 15 West 6th street, Cincinnati, Ohio.

Ignition Valve Timing and Automobile Electric Systems. $1.50. Stanton & Van Vilet Co., 2537 South State street, Chicago, Ill.

Ignition Motor Car Starting and Lighting. $1.50. D. Appleton & Co., 29-35 West 32nd street, New York, N. Y.

Question for May

1. I have often heard it said that a grounded aerial acts as a protector of buildings rather than a hazard during lightning storms. Will you please explain the reason for this?—R. M.



Mono-Rail Hoist That Requires Little Head Room

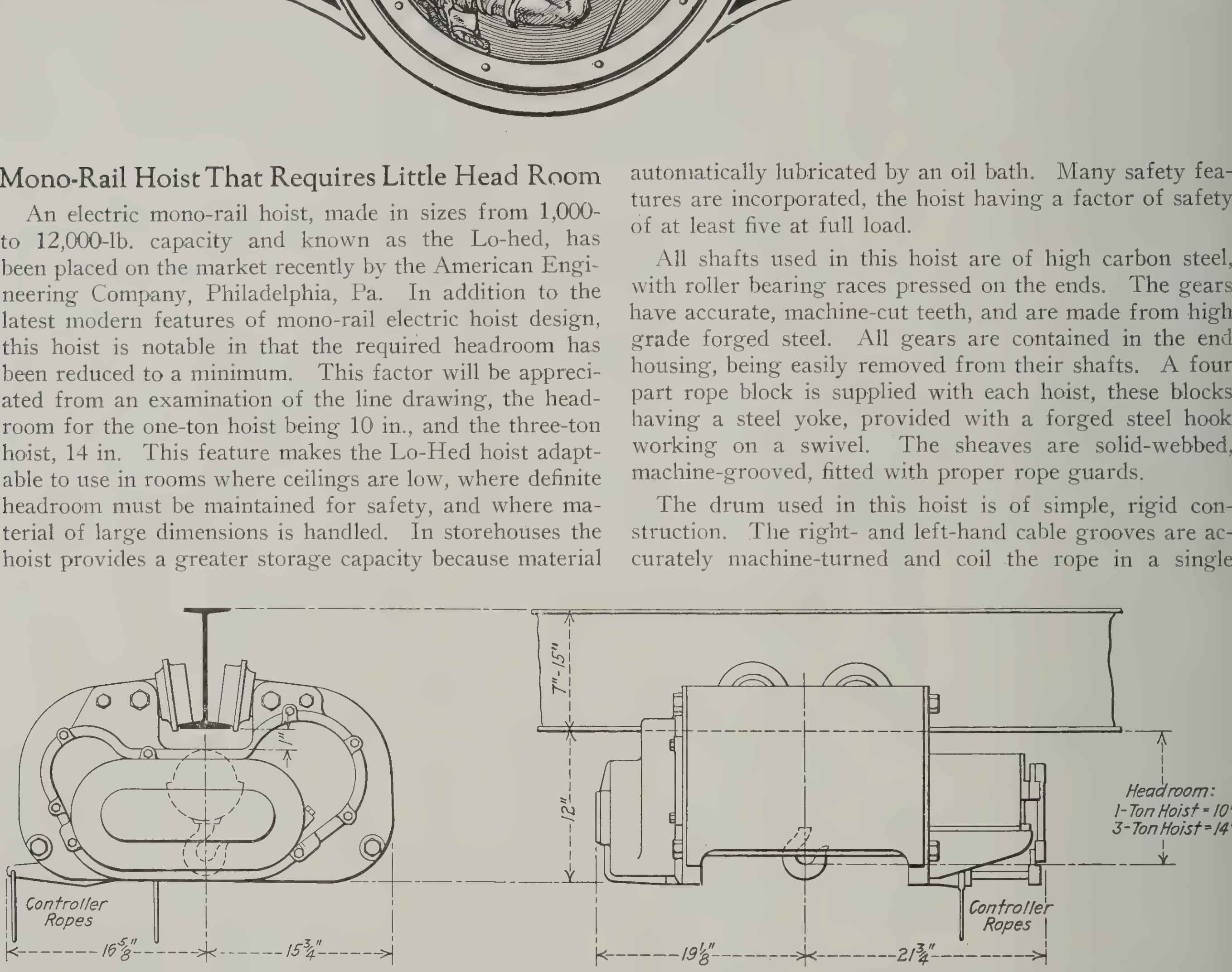
An electric mono-rail hoist, made in sizes from 1,000- to 12,000-lb. capacity and known as the Lo-hed, has been placed on the market recently by the American Engineering Company, Philadelphia, Pa. In addition to the latest modern features of mono-rail electric hoist design, this hoist is notable in that the required headroom has been reduced to a minimum. This factor will be appreciated from an examination of the line drawing, the headroom for the one-ton hoist being 10 in., and the three-ton hoist, 14 in. This feature makes the Lo-Hed hoist adaptable to use in rooms where ceilings are low, where definite headroom must be maintained for safety, and where material of large dimensions is handled. In storehouses the hoist provides a greater storage capacity because material can be stacked higher; also larger castings can be handled.

In addition to minimum headroom this hoist has a minimum number of working parts, making a simple and durable design. All parts are readily accessible. By taking off the outside metal cover any part can be easily inspected or moved without disassembling the main body or frame of the machine. The motor can be removed while the load is on the hook. This hoist is economical in the use of power having a mechanical efficiency of over 80 per cent. A strong and durable straight spur gear drive is provided. Frictional losses are reduced by the use of Hyatt roller bearings throughout. The Alemite system of high pressure lubrication is used on all bearings not automatically lubricated by an oil bath. Many safety features are incorporated, the hoist having a factor of safety of at least five at full load.

All shafts used in this hoist are of high carbon steel, with roller bearing races pressed on the ends. The gears have accurate, machine-cut teeth, and are made from high grade forged steel. All gears are contained in the end housing, being easily removed from their shafts. A four part rope block is supplied with each hoist, these blocks having a steel yoke, provided with a forged steel hook working on a swivel. The sheaves are solid-webbed, machine-grooved, fitted with proper rope guards.

The drum used in this hoist is of simple, rigid construction. The right- and left-hand cable grooves are accurately machine-turned and coil the rope in a single layer. These drum grooves are machined to a depth sufficient to take the full diameter of the cable. The cable is connected to the exterior of the drum in a simple manner and can be easily removed or replaced. The controller used in this machine is built especially for hoist service. All parts are fireproof and are completely protected from dust and moisture. A return spring holds the controller in the "off" position. As soon as the operator releases the pull on the controller handles, the hoist stops.

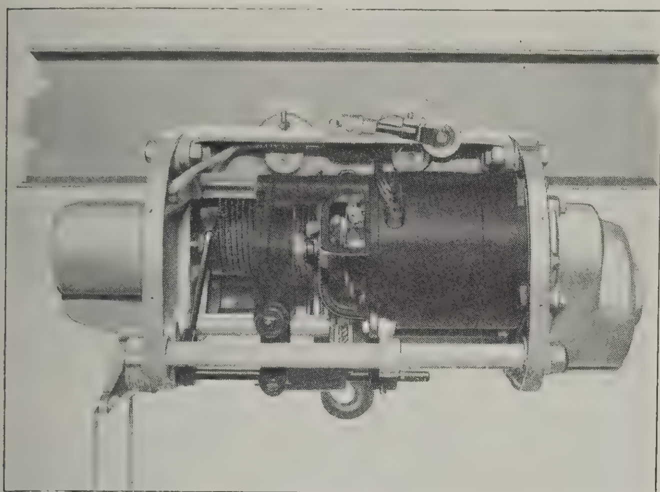
The motor is of standard make, fully enclosed. All motors are equipped with high grade ball bearings and large diameter shafts. No long shaft extensions are required. Motors are fully enclosed when necessary and are guaranteed for the rated capacity of the hoist.



Side and End Views of 1-Ton Lo-Hed Hoist. The Design Plainly Provides Minimum Headroom for a Hoist of that Capacity

The automatic mechanical lowering brake runs in an oil bath and is provided to control the lowering speed. It is of the screw and disc type, geared to the intermediate shaft and having three discs. Its construction is standard and the same as used on high grade cranes.

The automatic holding brake works on a pulley mounted on the hoisting motor shaft proper and is lined with an asbestos brake band lining. It is operated by a cam



Side View with Cover Removed. The Simplicity and Accessibility of Motor and Controller Are Evident

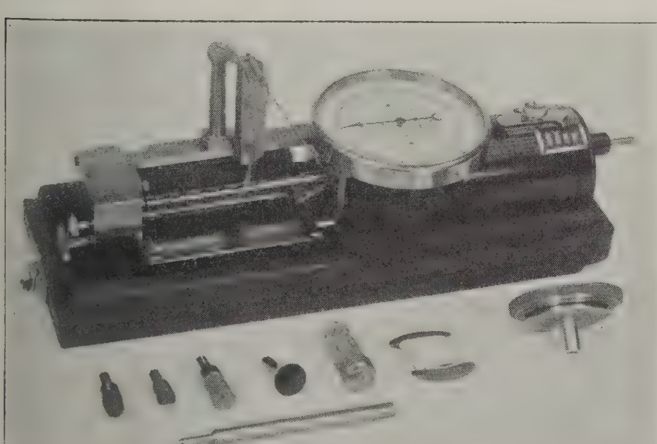
on the controller shaft and holds the load safely at any point.

When the load block has reached its upper limit of travel, an automatic device serves to break the electrical circuit and apply the holding brake. This device is positive in its action, a valuable safety feature.

The Lo-Hed hoist is adapted to many uses in railroad locomotive shops. It is also a great potential labor saver in car shops, storehouses, foundries, power plants and wherever the railroads have material-handling problems.

Recording Speed Indicator

A device known as the O-Z hand tachograph has been developed by O. Zernickow, 15 Park Row, New York,



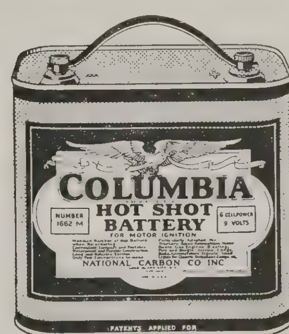
The O-Z Tachograph

N. Y., which gives an accurate clear picture of speeds which are tested and shows all fluctuations that have occurred. The device consists of a single spindle, selective range, hand tachometer to which a recording mechanism is attached.

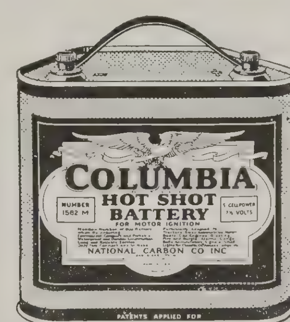
The paper strip is moved by two rollers driven by clockwork and the speed of paper travel can be changed, stopped or started at any time regardless of whether the tachometer is in operation or not. The instrument is equipped with two pens, one of which indicates fluctuations in speed and the other which marks the time in seconds at one side of the chart. The speed is indicated on the tachometer dial during the test and the entire width of the chart is available to the pen which records speed. If the pen runs off the chart, the next speed range on the tachometer is engaged by a gear shift thumb slide. The recording mechanism can be attached to any of the O-Z hand tachometers.

Changes in Dry Cells

The National Carbon Co., Inc., has recently brought out two new types of Columbia "Hot Shot" batteries of the steel case construction, as follows: No. 1562 M-5

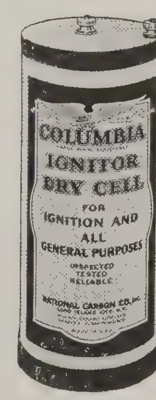


9 Volt Combination



7½ Volt Combination

cells in series arranged in two rows giving 7½ volts. No. 1662 M-6 cells in series arranged in two rows giving 9 volts. These two new batteries have the same design and appearance as the 1461 M Columbia "Hot Shot" Battery-4 cell power—6 volts—which was announced last fall.



Columbia Ignitor

Since the advent of the Columbia "Hot Shot" Battery it was felt desirable to so change the color scheme of the Columbia Ignitor that it will be comparable with the "Hot Shot" in both color and design. First shipments of Columbia Ignitors with the new jacket were begun on March 1, 1923. The colors of this jacket are gray, red and blue—similar in all essential details to the "Hot Shot" colors.

"Marlanite" Insulation

Marlanite Company, Barberton, Ohio, has introduced an insulation compound especially adaptable for radio parts, it is stated, due to the ease with which it can be drilled and cut. It is unaffected by moisture, the manufacturer claims, and will stand 300 deg. Fahr. without warping or softening. It is stated that tests on the material show that a panel 3/16 in. thick will stand 40,000 volts.

General News Section

The Association of Railway Electrical Engineers will hold its annual convention in the Hotel La Salle, Chicago, from November 6 to 9 inclusive.

The car painting shop of the Canadian Pacific at Vancouver, B. C., was completely destroyed by fire on the night of April 10. Six Pullman cars and adjoining freight sheds were also damaged, the total loss being estimated at about $250,000.

A number of the 41 electric passenger locomotives which have been in service on the New York, New Haven & Hartford for the past 16 years have now been run more than 1,000,000 miles. The record is one of which any railroad may be justly proud.

The Erie Railroad will renew the overhead contact wire between Avon and Rochester on the electric line which runs from Mount Morris to Rochester. The distance from Avon to Rochester is 19 miles. The contact wire now in use is steel and it will be replaced with Phono-Electric wire.

Pullman in the Movies.—A motion picture has been made by the Pullman Company comparing traveling in 1859 and in 1923. The film shows the first Pullman car with passengers wearing costumes of pre-Civil War times and illustrates in part the construction of the sleeping car. The picture is designed to inform people regarding the methods employed by the Pullman Company and to illustrate the safety and comfort of travel today; and will be shown throughout the country.

The American Insulated Wire & Cable Co. of Chicago, Ill., is now manufacturing magnet wire, having begun operations April 1. Its products are sold under the trade name A-1 Magnet Wire and consist of the following: plain enameled; single cotton covered; double cotton covered; single cotton enameled; double cotton enameled; single silk covered; double silk covered; single silk enameled, and double silk enameled. A factory manager has been secured who has had 20 years experience in this field and who has supervised the production of upwards of 60,000,000 pounds of magnet wire to meet every condition of use.

The Johns-Pratt Company, Hartford, Conn., announce that arrangements have recently been made with the Curtin Mill Supply Company, Houston; Globe Supply & Machinery Company, New Orleans; Hide, Leather & Belting Company, Indianapolis; Hardy & Dischinger, Toledo; Rathbun Company, El Paso; The Miller Supply Company, Huntington; Walworth-Ohio Company, Cleveland, and the Wayne Belting & Supply Company, Fort Wayne, as distributors on their power plant specialties, vulcabeston products, including compressed asbestos red fibre sheet packing, asbestos valve stem and rod packing, asbestos air pump packing, asbestos pump valves and asbestos valve discs.

The Electric Storage Battery Company, Philadelphia, Pa., announces a plan for the purchase of the company's stock by its employees who desire to become stockholders. Under the plan, employees of the company on May 1, 1923, who have served continuously for the previous two years or more, may buy one share of common stock at $53 a share for each $500 of their annual compensation but not exceeding 20 shares to any one employee; payment for the stock must be made by installments at the rate of one dollar a share a month. If an employee leaves the service of the company before his stock is fully paid for, his purchase agreement shall be canceled and the net amount paid in by him on the stock shall be returned to him with interest at the rate of five per cent per annum. If the present rate of dividends, one dollar a share per quarter, continues, stock subscribed for at $53 a share will be fully paid for after 40 months; that is $40 a share will be the amount paid by the purchaser and $13 a share will be the amount credited from dividends.

Progress of Austria's Hydroelectric Program

During 1922, ten hydroelectric plants of more than 500 horsepower capacity each and having a total capacity of 22,600 horsepower were completed and put into operation. Eight additional plants on which work was started will have an aggregate of 33,000 horsepower. In addition, some work was done on 895 plants all of less than 500 horsepower capacity.

Chilean Railway Operates First Electric Train

The first electrically-operated train on the Chilean State Railways made a successful trip from Santiago to Tiltil and return on Tuesday, April 17, according to a cablegram received by the Westinghouse Electric & Manufacturing Company. The train was operated by President Alessandri of Chile, as engineman, and the American Ambassador to Chile, was carried as a passenger.

The distance between Santiago and Tiltil is about 30 miles and constitutes the eastern end of the electrified line of 144 miles from Santiago to Valparaiso. When completed, 33 electric locomotives will be used on the electrified section.

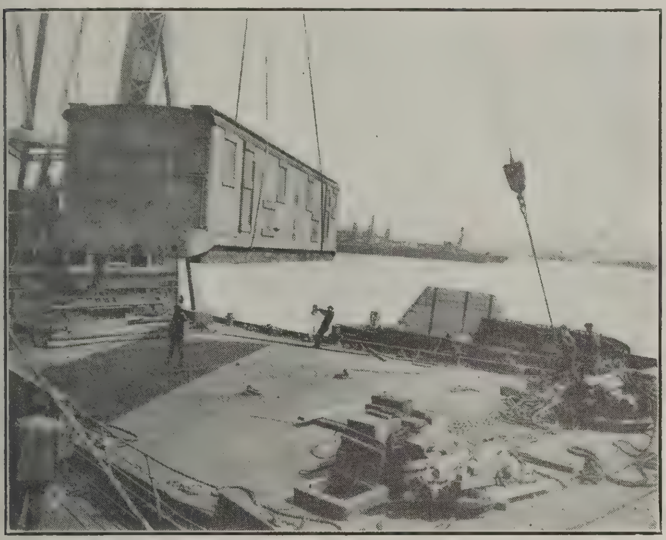
American Electric Locomotives for Spain

Three of the six 100-ton, 3,000-volt d. c. electric locomotives, comprising part of the $1,500,000 contract for the electrification of 40 miles of the Spanish Northern Railway were shipped by the International General Electric Company on the S. S. *Florinda* (Garcia & Diaz, agents) on April 9 from South Brooklyn, N. Y., in the presence of a party of engineers and officials including the Spanish consul general and his staff.

The electrification for which this equipment is supplied will be carried out by the Sociedad Iberica de Construc-

ciones Electricas of Madrid, Spanish representatives of the International General Electric Company, and is of particular interest because it is the first 3000-volt direct current road to be installed in Europe. It is known as the Pajares Grande division.

These locomotives are of particular interest, since they are a somewhat novel design using three axles instead of the usual two axle trucks. They are of the swivel truck type and each is equipped with six 400-hp. motors, giving a capacity sufficient to handle a full tonnage train up the



Hoisting One of the Electric Locomotives on Shipboard for Transportation to Spain

2 per cent grades at 22 miles per hour. On the return trip the trains will be held by the regenerative braking.

In addition to the locomotives, the contracts placed with the Spanish company include equipment of two 3000 kw. sub-stations and material for overhead distribution for the entire electric zone. Shipment of this latter equipment has already been made and is being installed by the Spanish company.

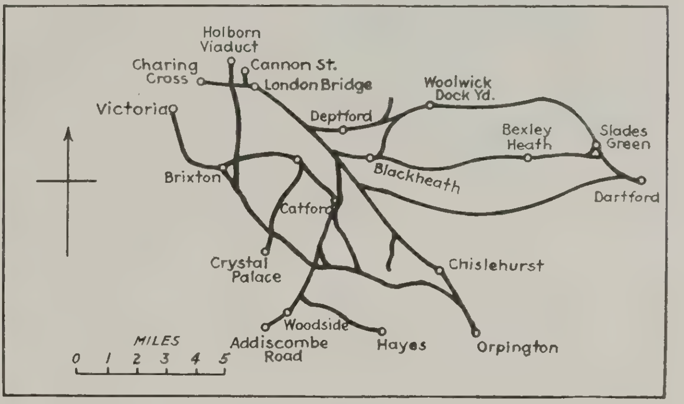
Southern Railway in England to Electrify Suburban Lines

Contracts for material and electric power have been let in connection with the long deferred electrification of the suburban lines of the South Eastern section of the Southern Railway (England). The routes to be converted from steam to electric operation are shown on the map and it will be noted that the scheme covers all the suburban lines within a radius of about 15 miles of the London terminal stations and includes both the old Chatham & Dover and South Eastern Railways.

The entire scheme covers 234 route miles, although the work now in hand involves a route mileage of 94 miles or a single track mileage, including sidings, of 210 miles. The routes which are to be electrified are particularly suitable for electrical operations by reason of the dense traffic which must be handled. It is expected that electric operation by making possible both greater speed and permitting a greater number of trains will improve the service by 30 per cent.

The Southern Railway Company has entered into an agreement with the London Electric Supply Corporation, Limited, under which that company will supply power from its Deptford station, which is to be extended for the purpose. Power will be distributed from the power house to sub-stations located throughout the suburban area where it will be converted from the three-phase alternating current to 600-volt direct current and delivered to the conductor rail. It is intended that the rolling stock for the electrified section will consist of about 60 eight-car trains, each composed of 62-ft. cars. Each train will seat about 700 passengers and will be equipped with eight 300-hp. motors.

The original estimate of the cost of the work was £5,500,000 (about $25,500,000 at the present rate of exchange) and a guarantee covering this amount has been given under the provisions of the Trade Facilities Act. The most important contract for material which has been let at the present time is with the Cargo Fleet Iron Company, Limited, of Middlesbrough for 7,500 tons of conductor rail.



Suburban Lines of the Southen Railway (England) Which Are to Be Electrified

Personals

E. S. Herman, welding instructor, C. R. I. & P., with headquarters at Chicago, has been assigned to the second district with headquarters at El Reno, Okla., reporting to the mechanical superintendent.

V. B. Vogel, welding instructor, C. R. I. & P., with headquarters at Chicago, has been assigned to the first district with headquarters at Des Moines, Iowa, reporting to the mechanical superintendent.

A. E. Ganzert, electrical supervisor, C. R. I. & P., with headquarters at Chicago, has been assigned to the first district as district electrical supervisor with headquarters at Des Moines, Iowa, reporting to the mechanical superintendent.

E. R. Chinberg, electrical supervisor, C. R. I. & P., with headquarters at Kansas City, has been assigned to the second district as district electrical supervisor with headquarters at El Reno, Okla., reporting to the mechanical superintendent.

A. G. Mueller, of the C. R. I. & P., formerly electrical foreman at Valley Junction, Iowa, has been appointed supervisor of automatic train control with headquarters at Des Moines, Iowa, reporting to the mechanical superintendent. His supervision covers the installation, operation and maintenance of the automatic train control equipment installed on the locomotives.

Frank E. Starkweather, assistant signal engineer of the Pere Marquette with headquarters in Detroit, Mich., has been promoted recently to electrical engineer with the same headquarters. Mr. Starkweather was born August 5, 1885, at Saginaw, Mich. He graduated from high school in 1903, and later studied electrical engineering. Mr. Starkweather served in the engineering department of the Bartlett Illuminating & Power Company in 1903, and in 1904 and 1905 worked for the General Railway Signal Company on signal construction. During 1905 and 1906 he was employed as chief electrician for the Pere Marquette Coal Company and later he entered the power and switch department of the Michigan State Telephone Company. In 1907, Mr. Starkweather entered railroad service on the Pere Marquette as an electrician in the signal department, and for three years beginning in 1908 he was a maintainer on interlockings. He was promoted to electrical foreman in 1911, and two years later was appointed chief electrician, which position he held until 1916, when he was promoted to assistant signal engineer. On April 1, 1923, Mr. Starkweather was promoted from assistant signal engineer to electrical engineer.

Frank E. Starkweather

Hugh Pattison, who during the past two years has been employed by the Illinois Central in connection with the electrification of that road, has been appointed engineer of electric traction of the Virginian Railway. Mr. Pattison graduated from the Johns Hopkins University as an electrical engineer in 1892. The first work that he did upon leaving college was the wiring and installation of electrical apparatus on naval vessels at the Navy Yard in Norfolk, Va. At this place he held the position of foreman. He became assistant engineer with Sprague, Duncan & Hutchinson, consulting engineers of Baltimore, in 1893. Shortly afterward he became associated as engineering assistant with Frank J. Sprague, vice-president and technical director of the Sprague Electric Company in New York. This association continued until 1903, during which time Mr. Pattison assisted in equipping and operating multiple unit control on the Boston Elevated and Brooklyn railroads. In 1905, Mr. Pattison joined the Westinghouse, Church, Kerr Company as an engineer, and from that time until 1911, during the electrification of the Pennsylvania tunnel into New York, Mr. Pattison was assistant engineer of electric traction for George Gibbs, consulting engineer. A little later he had charge of the electrification of the West Jersey & Seashore Railroad, from Camden to Atlantic City. An experimental single phase electric railway on the Long Island Railroad was also built by him and numerous locomotive tests on the West Jersey & Seashore Railroad were carried out under his supervision. Mr. Pattison was appointed engineer in charge of the Chicago Association of Commerce Committee in the study of smoke abatement and the electrification of terminal railroads in Chicago in 1911. After completing his work in Chicago, he was retained by the Westinghouse Electric & Manufacturing Company, and was engaged in making special engineering studies under the direction of F. H. Shepard. He resigned this position when he entered the employ of the Illinois Central.

Obituary

George H. Guy, secretary of the New York Electrical Society, died recently in the Long Island College Hospital of pneumonia. Mr. Guy held the position of secretary for forty years. He was seventy-six years old.

Schuyler S. Wheeler, electrical inventor, engineer and manufacturer, who was president of the Crocker-Wheeler Company of New York and Ampere, N. J., died suddenly on Friday, April 20. Mr. Wheeler was a member of many engineering societies. He was perhaps best known by reason of his activities in connection with the development of numerous inventions and particularly in the design and manufacture of electric motors.

Trade Publications

Type OD Safety-First Fuse Box is the subject of Leaflet 20,005 just printed by the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa. This fuse box is for use on circuit one to one hundred amperes and seventy-five volts.

Multi-Speed Alternating Current Motors.—A profusely illustrated 12-page bulletin has been issued by the Louis Allis Company, Milwaukee, Wis. The booklet illustrates and describes many shop applications of motors of this type and lays particular stress on the ability of the multi-speed a. c. motor to maintain a selected speed under changes of load.

Electric Controlling Devices.—The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has issued a new discount sheet, dated April 9, 1923, which supersedes the previous sheet, 5-A-1236, dated July, 1921. This discount sheet applies to apparatus listed in the company's controller department catalogue and it has been sent out together with an announcement to the effect that due to the advance in prices of the material entering into the manufacture of products, it is necessary to increase sales prices.

The Westinghouse Electric & Manufacturing Company recently issued leaflet 2390-A, describing the Type E, engine-driven alternating-current generators. In this leaflet the construction of these generators from 50 to 3,000 kva. is illustrated and described. These generators are applicable to all prime movers, being suitable for direct connection to steam, gas, and oil engines, or slow speed horizontal water-wheels. The company has also issued leaflet 3477-B, which is descriptive of the hot spot indicator for transformers. The device is illustrated with photographs and wiring diagrams showing how the indicator functions and how it is located in the transformer.

Railway Electrical Engineer

Volume 14 JUNE, 1923 No. 6

Generally speaking, heating by electricity is considered expensive, if, indeed, not extravagant. Nevertheless, there may be instances where it is more economical to heat by electricity than by other available means.

Electric Heating May Be Economical

One place where consideration should be given to the advantages of electric heating is in passenger trains on electrified roads. This is particularly true for roads which are not subjected to extreme cold weather for long periods of time. The usual method for heating trains in such electrified territory is by means of an oil-fired steam boiler located on the locomotive. These boilers are frequently a source of much annoyance through faulty operation. If a boiler of this type fails to work properly, it means that the particular locomotive on which it is mounted cannot be used for passenger service, no matter how perfectly all other parts of the equipment may be functioning. The oil-fired boiler requires approximately four tons of water and several hundred pounds of fuel oil. The oil must be carried on the roof of the locomotive where it cannot be considered as other than a hazard; there are instances where the oil has caught fire from the pantagraph connections.

Of course, it cannot be denied that the oil is somewhat cheaper per unit of heat derived than is electricity, but when the handling of the oil, storage, fire hazard, train line and steam hose connections, plus the maintenance and depreciation of a highly specialized boiler, are taken into consideration, it is questionable if in some installations, particularly where the weather is moderate for the greater part of the winter, it would not be cheaper to use resistance units directly connected to the power supply system.

There is perhaps no other railroad officer who is called upon to supervise so many different kinds of work as the electrical engineer. Almost every railroad department has use for electrical energy in one way or another and in most instances the electrical engineer is the one who is responsible for the proper installation and efficient maintenance of all electrical devices. He must have a working knowledge of every application of electrical energy in the steam railroad field, and that is saying a great deal. Many of the devices, however, are similar in character and a knowledge of the underlying principles of one makes it easier to understand the others. Usually, familiarity with the major applications commonly found in railroad practice is sufficient to meet most new problems when they present themselves. For example, the electrical engineer who is familiar with car lighting, locomotive lighting, electric welding, electric traction, installations of motors and general lighting is in a pretty good position to handle almost any electrical problem that is likely to come his way.

Your Job and Your Helper

These subjects are the very ones which your magazine, the *Railway Electrical Engineer,* is endeavoring to cover from month to month. The field is a big one, however, and it is not always possible to present an article on each one of these topics each month. Occasionally we have had a subscriber tell us that there was not enough of this or that type of article in the paper. Of course, they refer to material that they are most interested in. Perhaps one issue may fall short of the particular material desired but we aim to keep our readers posted on all the important developments in electrical applications on the railroads and we make a special effort to keep each number balanced so far as covering the important phases of the work is concerned. We greatly appreciate comments and co-operation from our subscribers. The *Railway Electrical Engineer* is your paper and we believe you can utilize it as a silent but most efficient helper.

Electrical department organization is a matter which can well be given attention by a majority of the railroads. A few roads have organizations of which they may justly be proud, but there are many more of which it may be said that their departments are well but not thoroughly organized. This may be explained about as follows: There is an obvious need for well-defined departments. Particularly where there is a possibility of injury to persons or property, high departmental walls must be set up so that certain persons, and no one else, are responsible for practices and for maintenance of equipment. Unfortunately such organization tends to make for much duplication of effort. Where the department is large and well organized the efficiency is greatly improved because where the matter of responsibility is not vital, work can be divided up and done by the forces most conveniently located.

Electrical Department Organization

Regarding lack of organization, the electrical department is probably the worst offender, but it is neither the fault of the department nor of the railroad. The first railroad was put in operation nearly 100 years ago. The trains were hauled by steam locomotives, the shop machinery was run by steam engines and electrical apparatus as a practical asset was unknown. As electrical apparatus of practical value was developed, it was adapted by each of the several already well-developed departments and this practice to a considerable extent has continued.

Now nearly 99 per cent of the track of the Class I roads is still steam operated, but there is scarcely a machine tool

that is not motor driven; buildings and yards are electrically lighted, locomotives and passenger cars carry their own electric power plants, electric power is used extensively for welding and cutting metals and for the operation of pumping plants and air compressors, while more recently electric power has found an important place in the operation of train control equipment. At the last exhibit of the Railway Supply Manufacturers' Association, 30 per cent of the exhibitors were showing apparatus for railroad use which was in part at least electrical. There is an obvious need for better organization in this rapidly increasing branch of the industry and suggestions for the solution of the problem are needed.

Rail Motor Cars

There are many different types of rail motor cars to be had and enough will soon be known about them to permit the prospective operator to pick out the one best suited to his needs. Rail motor cars are particularly suitable for use in sparsely populated districts and branch lines where the traffic is not heavy enough to pay for the operation of a steam train. They are also used to good advantage where there is a need for more frequent service than can be supplied economically by a steam train. The cars available include gas-electric, high pressure steam, storage battery and various types and sizes of gasoline cars.

Each type of car has its own inherent merits and its limitations. The gasoline cars perform yeoman service but the rail shocks to which the motor is subjected make this type of service particularly severe as applied to gasoline engines in comparison with service in automobiles. This is particularly true where the engine used is large. Aside from the fact that the service is severe, the average engine terminal is not equipped for the maintenance of gasoline engines. Development of the cars or of the maintenance facilities are yet needed to insure 100 per cent dependability. In the case of the gas-electric car, the engine receives no direct road shocks; but a few complications are added and some of the same difficulties remain. Operators of steam cars must also contend with similar maintenance problems.

The storage battery car has the great advantage of simplicity. It is comparatively free from interruptions during operation and very few defects short of an actual smash-up will prevent the car from reaching its terminal. It is simple to operate and only a few lessons are required to teach any normally intelligent man how to handle the controller and the air brakes. The car runs quietly, is free from vibration and the high tractive effort is of great value in winter service. Such disadvantages as may be offered include the weight and cost of the large battery and the fact that the car cannot be moved from one line to another without providing charging facilities for the battery. From such results as have been obtained on the Canadian National Railways, it would appear that the storage battery car will best meet the greatest variety of service requirements.

The ideal car is one which is not too costly, that will not be easily damaged by road shock, that is simple to operate, that can supply plenty of power when it is needed and that is thoroughly dependable. This may prove to be one of the existing types or it may be a modification of one or more of them. The subject of rail motor cars will be discussed at the next annual meeting of the Association of Railway Electrical Engineers. It is in the hands of an able committee and those interested in the subject will do well to keep in touch with the activities of the association.

New Books

Railroad Electrification and the Electric Locomotive. By Arthur J. Manson, Manager Transportation Division—New York, Westinghouse Electric & Manufacturing Company. 332 pages, 6 in. by 9 in. 149 illustrations, 19 tables. Bound in cloth. Published by Simmons-Boardman Publishing Company, New York, U. S. A. Price $4.00.

The future of electrically operated motive power as a factor in modern railway transportation, is no longer doubtful. From the early experiments, specialized in character, the growth of electrification has continued until today it supplies the only practical solution for many important traffic problems.

This book is a comprehensive treatment of the subject of electrification and of the construction of the electric locomotive. After dealing in a brief way with some of the outstanding and most important advantages which may be expected to result from the electrification of existing steam railway facilities, either of an entire system or of certain sections of the line, the author has explained the underlying theory of common electrical phenomena, and particularly those which relate to the application of electricity to railway operation. The generally accepted types of motors used to supply power for electric locomotives, and for multiple-unit trains, are also described.

Modern types of electric locomotives are discussed at length and such features as air brake equipment, methods of control, regeneration, transformer equipment, pantagraphs, third-rail shoes, and types of drives are fully explained.

A portion of the book deals with the principles of train operation and a comparison of the inherent advantages of electric and of steam locomotives. Curves have been extensively utilized for illustrating the operating characteristics of motors, locomotives, and train service. The solution of an actual electrification problem dealing with the factors influencing the choice of an electric locomotive for an installation of a given character is also provided.

The book also includes an appendix which reviews briefly the history and salient features of various American electrification projects. Included in this section are eleven tables which show at a glance important characteristics and details of construction as applied to electrical operation of railways in every country where steam railways have been electrified, or where the initial installation was electrically operated.

Intricate technical details are not discussed but material is supplied, which may serve as a basis for further study of these details. The information is of such nature and is presented in such a way as to be very valuable even to those interested only in a general way in the subject. To those employees who are directly engaged in the maintenance of equipment on railroads which are already electrified or the employees of railroads which may be electrified in the near future, this volume should prove to be especially valuable.

New York, New Haven & Hartford Inspection Building at Stamford, Conn.

Maintenance Methods Used By the New Haven

A System of Periodic Inspection of All Multiple Unit Cars Keeps Equipment in Prime Condition

By H. T. Morris

Engineering Assistant, New York, New Haven & Hartford Ry.

THE electrical equipment operated by the New York, New Haven & Hartford Railroad Company on the New York Division at the present time consists of fifty-two a.c.-d.c. passenger locomotives, thirty-eight freight locomotives, sixteen switching locomotives, thirty-five multiple unit motor cars and fifty-eight multiple unit trailer cars.

Fig. 1—General View of the Assembly Department at the Van Nest Shops

The a.c.-d.c. locomotives and twenty-nine of the multiple unit motor cars are arranged to operate from an overhead current supply at 11,000 volts, 25 cycles a.c., or 650 volts d.c., from a third rail. The remaining equipment is arranged to operate only from the supply at 11,000 volts 25 cycles a.c.

The maintenance of these several classes of equipment is quite complicated, due not only to the variety of the equipment itself, but to the different classes of service, and to local conditions preventing concentrating the inspection and maintenance at the fewest number of points. Passenger equipment including the multiple unit cars must meet the heavy demands for suburban service from several points, with due allowance for inspection and with a very small percentage for shopping margin. The service is not such as to permit the freight and switcher locomotives to be handled at the same terminals as passenger equipment, and freight equipment is frequently substituted in passenger service, particularly in the summer season.

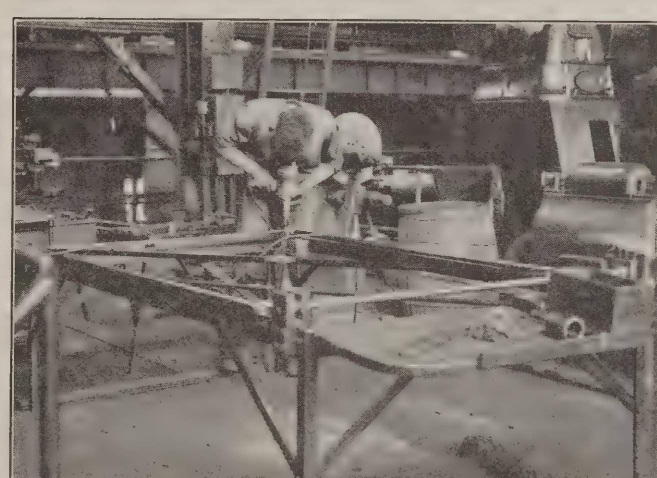


Fig. 2—Special Fixture Used for Assembling Pantograph Top Frames to Insure Proper Operation When Installed

At present, the arrangement is to use the Van Nest Electric Repair Shop as the point where heavy inspec-

tion and overhaul work on all classes, and regular periodic inspection of freight and switcher equipment is done. No train service is cared for at this point.

At Stamford, Connecticut, the passenger locomotives and multiple unit cars are inspected and running repairs taken care of. Multiple unit trains and certain local trains are made up at this point, and locomotives are also provided for passenger service, using that point as a terminal or for changing power.

At Grand Central Terminal, New Haven, New Rochelle, Port Chester and Oak Point, the maintenance forces do only light repairs and arrange for the assignment of locomotives and equipment to trains originating or terminating at these points.

All electrical equipment with the exception of multiple unit trailer cars is inspected on a 2,500 mile basis, the trailer cars being inspected every three months. Passenger locomotives are given a general overhaul on a 200,000 mile basis, freight and switching locomotives on a 100,000 mile basis.

Van Nest Electric Repair Shop, Van Nest, N. Y. C.

On account of the several points at which maintenance work is done, interchangeability of wearing parts is of great importance, and many special tools and fixtures have been built up at Van Nest Shop to insure this interchangeability. The general practice is to remove a defective unit from equipment at any point where it is reported, and forward the defective part to Van Nest Shop. It is there repaired and returned for service in a car specially arranged for the transportation of motors and the ordinary supplies. Most of this repair work on small parts is done in what is known as the assembly department shown as Fig. 1, this department also making repairs on all switching equipment and similar parts removed from locomotives being overhauled.

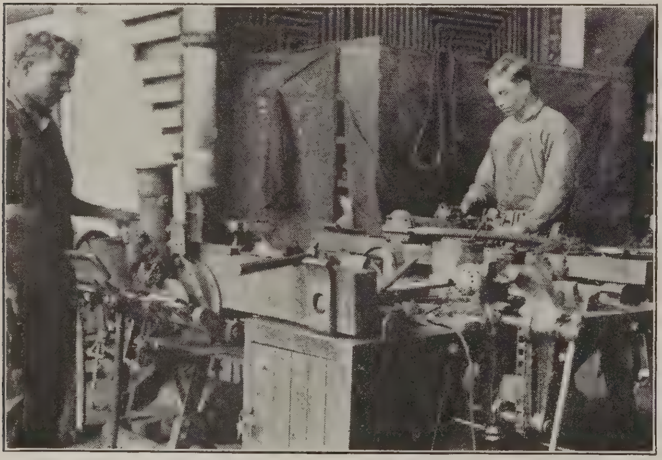


Fig. 3—Special Bench Fixtures Are Used in Overhauling and in Testing Third Rail Shoe Mechanism

Fig. 2 shows a special fixture made up for the assembling of pantagraph top frames, and all such units used on all electrical equipment are assembled in this fixture, to insure proper operation when installed on the trolley itself. The overhead clearance in the d.c. zone is so small that the trolley must come down very close to the roof and it is held down by air pressure. In case all parts are not properly adjusted and fitted, a delay may result when leaving the d.c. zone if the trolley will not raise promptly.

Fig. 3 shows the special type of third rail shoe used on a.c.-d.c. equipment being overhauled in the special bench fixtures used. On account of the clearance being different in the two zones of operation, it is necessary to have a folding mechanism which introduces a number of complications not ordinarily met, and special care must be taken to insure proper operation, even under conditions of ice and snow. Each workman is provided with a hose connection at the air pressure used, to permit testing for proper operation and to check the correct contact shoe position. Fig. 4 shows the mechanism mounted on the truck both in the d.c. service position and Fig. 5, the same shoe folded upward for service in the a.c. zone.

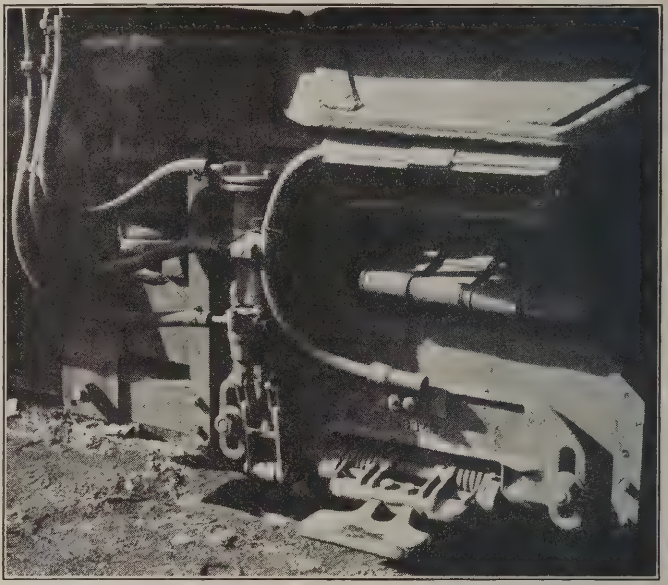


Fig. 4—Third Rail Shoe In Operating Position—In This Position the Multiple Unit Cars Operate on Direct Current at 650 Volts Collected From the Third Rail

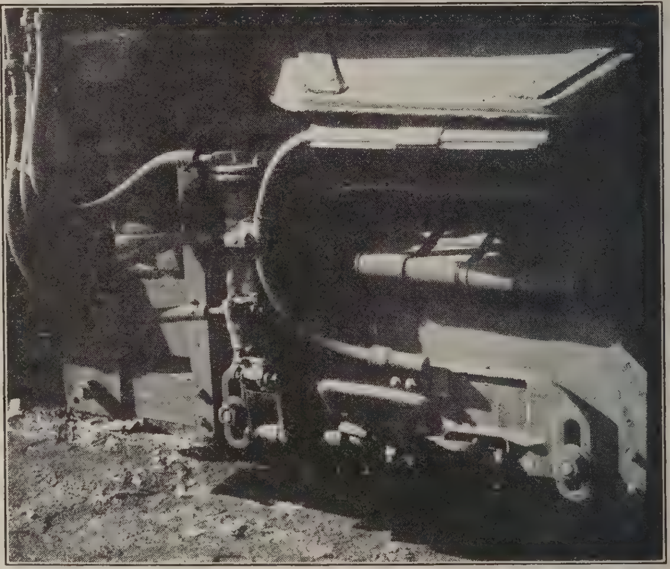


Fig. 5—Position of Third Rail Shoe When Car is Operating on Alternating Current Collected From Trolley

The equipment in use has been purchased over a period of about fifteen years and includes many special developments in type of apparatus and complete locomotives. The railroad company jointly with the manu-

facturers, about eight years ago, worked up a system of standardization to eliminate the great variety of special parts originally used. The power supply has also been increased in capacity and changes were necessary from a standpoint of safety.

To cover such items, a list of changes required for each class of equipment is maintained at Van Nest Shop, and whenever equipment is shopped, such of this work as can be conveniently done, is taken care of. A record is kept showing the date such a change is made.

This list provides a record of desirable or necessary changes to be applied to new equipment purchased in order to maintain standards that have been satisfactory in service.

Multiple Unit Equipment

The New Haven multiple unit equipment is designed to operate in trains consisting of one motor car and two

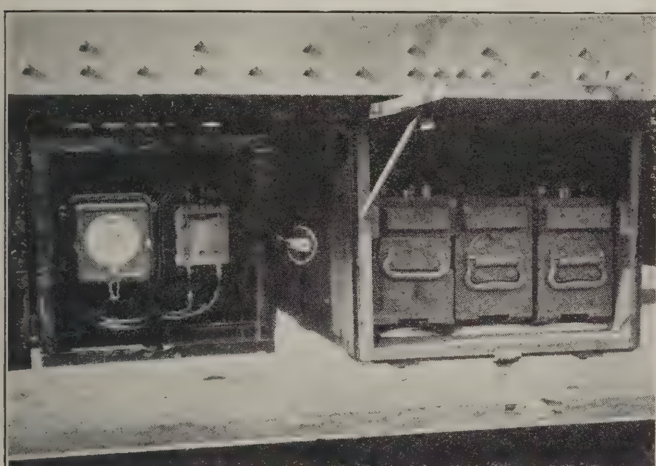


Fig. 6—Ampere-Hour Meter and Edison Storage Battery Under the Car Body

trailers, or in multiples of this combination. As the changeover from a.c. to d.c. or vice versa is made at approximately 30 miles per hour, all apparatus affected must be electrically or electro-pneumatically operated and controlled from the engineman's control station. This feature makes it necessary to provide unusually careful inspection of all apparatus used in this changeover, as a failure of apparatus to function will quite often result in a train delay.

Trail cars are inspected every three months, the work usually being done out of doors. The equipment under the car consists of the battery, motor generator, the charging devices and changeover switches for a.c. and d.c. lighting. Some of the equipment under the cars is illustrated in Figs. 6, 7 and 8. Contacts are cleaned, fingers inspected, value magnets and air cylinders cleaned and such lubrication as is necessary applied. The storage battery is checked for proper voltage and water added as needed.

In the engineman's compartments, the master controllers, push button boxes, brake valves, feed valves, whistles and signal switches are inspected for wear of fingers or other parts and lubrication applied as needed.

Trailer cars are sent to Van Nest shops when requiring paint or heavy repairs, but usually the painting is the limiting feature for shopping.

At the time of shopping, all equipment is thoroughly gone over, being removed from the car if necessary, and put in good condition for road service. The trucks are overhauled, and any other mechanical features on the car requiring repairs are taken care of.

Motor car equipment is inspected at night on account of the lack of space to handle the long cars in the shop at the same time with locomotive inspections.

On the motor cars there is a great deal more apparatus and it is inspected partly on a periodic basis and partly checked at each inspection. Fig. 9 shows a tabulation of the apparatus which is inspected periodically, suitable record being kept by car number so that it can readily be determined when car is out of service for inspection just what work it will be necessary to do.

The original design of a.c. oil circuit breaker required very close adjustment but with a later design the inspection time can be lengthened to six months and this inspection will then be made at the time the oil is changed, due to change of season.

The main motors are gone over at each inspection and the commutator condition noted, brushes and brushholders renewed, if necessary, and accumulations of carbon dust and dirt wiped off or blown out, and the air gap and lateral motion checked for wear of bearings. Lubrication is supplied to the armature and axle bearings in accordance with chart showing proper depth of oil to be placed in the wells. The waste is either removed if it appears to be in poor condition, or it is worked over sufficiently to insure proper lubrication after additional oil is applied. Gear cases use what is known as Crator compound, and it being very heavy,

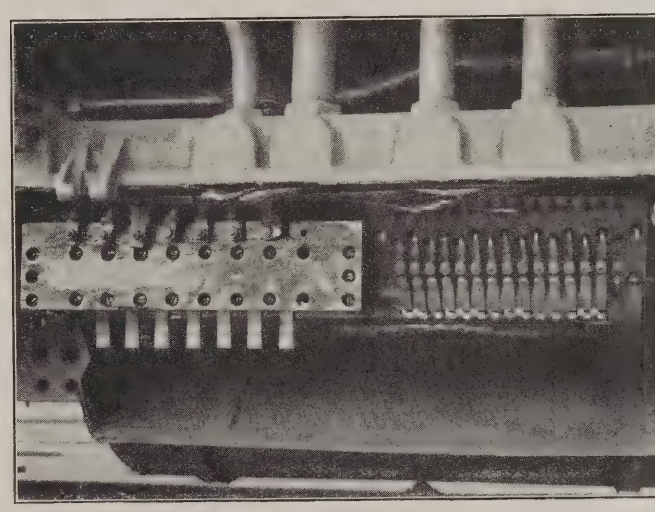


Fig. 7—Change-Over Switch Which is Operated When Propulsion Power is Changed From Direct to Alternating Current

is warmed up and poured into the cases, when weather conditions are such as to require this. Flexible gears are used on all motor cars.

The switch groups are opened making an inspection of all main and control terminals and the necessary arcing tips, arc box sides, or interlock fingers, are changed as required. Valve magnets and cylinders have a relatively long life on this class of equipment, but are changed if they show sluggish or irregular operation.

Other switching equipment is looked over in the same way to make sure that all terminals and contacts are not worn so badly that they need renewing and any loose contacts are tightened up.

Forced ventilation is used on these cars for the trans-

formers and main motors, the blower motor being practically the same as the compressor motor, and these motors must be inspected in a manner similar to the main motors, renewing brushes and lubrication, and cleaning. The later type blower motors are equipped with ball bearings and are lubricated with grease.

The grid resistors used on this equipment are heavy and it is customary to tighten up tie rods if possible, at each inspection, as there is a tendency for them to loosen up and cause burning between the plates. The battery and battery charging equipment is the same as used on trailer cars, and is inspected in the same manner. Water is added if needed, and when a battery appears to be in a rather poor condition, it is changed and the defective unit forwarded to Van Nest Shop for attention. Edison batteries are used on all of the equipment, and the charging is regulated by an ampere-hour meter. An insulation test of 1,000 volts is applied after inspection is complete to all main circuit apparatus, including separate tests on resistors and switch groups which are mounted on insulated bolts.

Air brake apparatus is tested to see that it functions properly and parts not covered by the table of periodic inspection are examined and put in proper condition for operation.

The car is tested out for proper sequence of switches and action of the auxiliary motors before releasing from the shops.

At every third inspection, the car is lifted from the truck center bearings and these parts inspected and lubricated. After each inspection, a form is filled out showing parts renewed, such as carbon brushes or brushholders, the general condition of main and auxiliary motors and just what other work was done. This is kept on file for checking at future inspections or shopping just what work will probably be necessary.

Periodically, motor cars are sent to the Van Nest shops up for mechanical defects, proper operation of doors and windows and all air brake devices. The brake valves, distributing valves and brake cylinders are inspected and cleaned at this time. Hydrostatic test is applied to the various air reservoirs.

All of the multiple unit equipment has not been purchased at the same time, nor is it all of the same type of car, and there have been quite a number of changes necessary. Originally the equipment was arranged for automatic control but due to the necessity for trailer operation and simplicity, the automatic features were removed and the substitution of new controllers and other devices on the old types of cars did not give the best possible arrangements for easy maintainance.

Fig. 8—Close-Up View of Switch Group and Interlocks on Multiple-Unit Cars

Non-automatic control also requires a train line of 31 wires using a twelve and nineteen point jumper. These control jumpers are given a test each six months for general condition, broken wires, short circuits, or other defects. After being tested and gaged for proper size and fits, a band of colored paint is applied to designate in service the period during which the last inspection was made.

CARS	No.1 Brake Valve	No.2 Brake Valve	Distributing Valve	Governor and Strainer	Safety Valves	Control Strainer	Door Strainer	Brake Relay	Shoe Relay	Alarm Whistles	Duplex Gages	Feed Valves	A.C. Circuit Breaker	Circuit Breaker Oil	Change Over and Reverse Cylinder	Switch Cylinder Magnets	Auxiliary Magnets	Trolley Cylinders	Brake Cylinders	Compressor Valves and Strainer	Crank Cases	Blower Shutters	Door Relays	Reverse Interlocks	Swivel Air Joints	Fuse Boxes	Armature Bearings
PERIODS	12 mos.	12 mos.	6 mos.	3 mos.	6 mos.	6 mos.	12 mos.	3 mos.	3 mos.	6 mos.	3 mos.	6 mos.	2 mos.	6 mos.	3 mos.	3 mos.	2 mos.	6 mos.	6 mos.	2 mos.	6 mos.	3 mos.	3 mos.	3 mos.	6 mos.	6 mos.	3 mos.
4036																											
4037																											
4038																											
4039																											

Fig. 9—Method of Tabulation of Periodical Inspection—Just What Work is Required to Be Done on Each Car is Quickly Determined

for paint, and at that time, the trucks are removed and dismantled, the motors also being dismantled, if necessary, for turning of commutators or other work.

While the car is at Van Nest shop, the electrical equipment is gone over more thoroughly than is possible at the ordinary inspection, and the various relays and magnets operating changeovers, third rail shoes, trolleys and other devices are removed, cleaned and tested for proper operation. It has been found that the average d.c. relay requires re-calibration and setting about every two years.

At the same time the car is being painted, it is checked

There must be output before there can be income.

What pride men take in their work they must take as members of an organization.

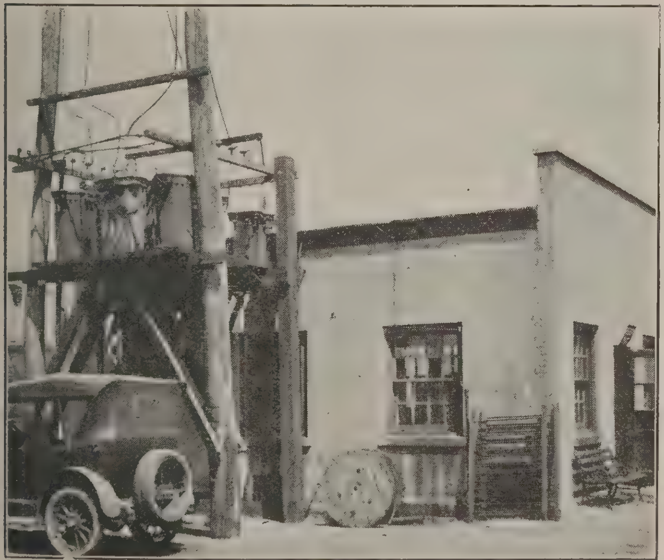
Nobody ever saw a booster out of a job very often or very long. Everybody is looking for his kind.

The New Erie Railroad Pier at Weehawken, N. J.

Electrical Equipment on Erie's Weehawken Pier

Convenient Lighting System and Numerous Elevators Combine to Expedite the Transfer and Storage of Materials

SIMPLE, durable and safe construction marks the installation of the electrical equipment on Pier C which the Erie railroad recently completed at Weehawken, N. J. The pier, which is unusual in a number of respects, particularly in the heavy timber construction used, replaces one of the four pier units destroyed by fire on November 3, 1921. Electricity is used principally on the pier for the operation of elevators and for lighting.



View Outside of Substation Showing the Transformer Platform

Power Supply

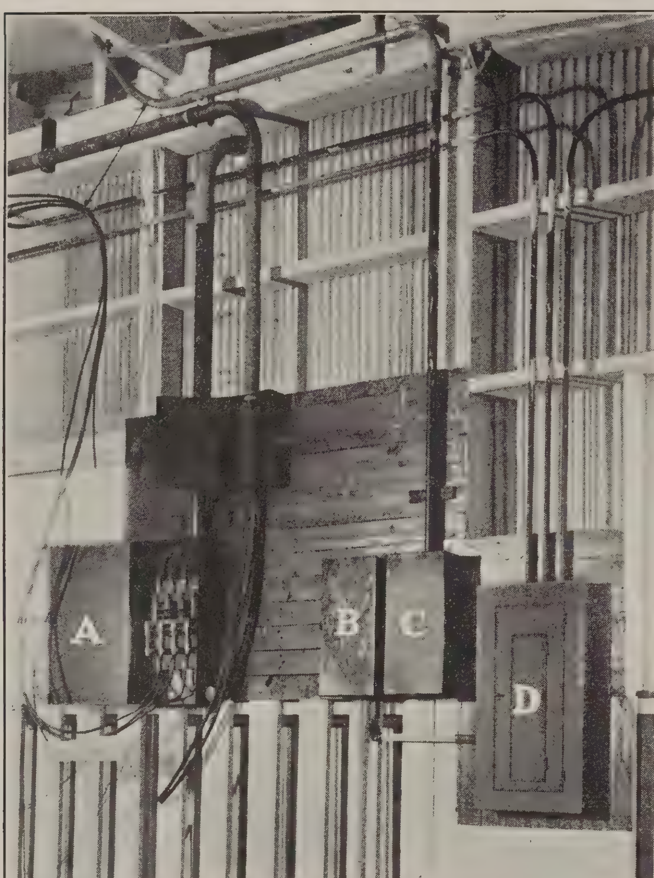
The power is taken from the Public Service Corporation of New Jersey's line. This company maintains a pole line along the river front at this point. Feeders carrying 2,300 volts, 2-phase, 4-wire system are brought down into a small sub-station building where they are taken through an oil circuit breaker and led to the transformers mounted on the wooden platform outside of the building. The power is stepped down through the transformers and delivered to another line as a 2-phase, 4-wire, 250-volt system. The sub-station was used as a point for controlling

Wires Looping from Pole Line to Entrance Fitting at the Pier

the energy used at the pier for the reason that it already existed, the building housing two rotary converters which supply 250-volt d. c. to nearby piers for the operation of gantry cranes.*

The new pier is located about 1,200 ft. north of the sub-station, but since the latter building was already constructed, and as there is always an attendant on duty it was the most economical way of controlling the high voltage line.

At the pier the conductors loop over to the building and enter by means of a special G. V. entrance fitting manufactured by the Gillette Vibber Company, New London, Conn. This particular type of fitting has the advantage of allowing a straight pull on the wires when drawing them in, and by means of an adjustable outlet head



Fuse and Switching Cabinets Located at the Point Where Wires Enter the Pier

permits the turning of the conductors in any direction desired. Three inch conduit leads down from the entrance, fitting into the pressed steel box *A*, containing a 4-pole knife switch and fuses. Up to this point no reduction in the size of wires is made, they being 500,000 circular mills from the transformer at the sub-station to the cut out box in the pier. On leaving this cut out box, however, the principal conductors are reduced in size to four 4/0 wires, which are led upward again in a 3-in. conduit. On reaching the top of the building these four conductors in the conduit are connected to four open conductors mounted on insulators, and this open wiring extends down the length of the pier just underneath the roof. These four open conductors are the lines which supply current to the elevators.

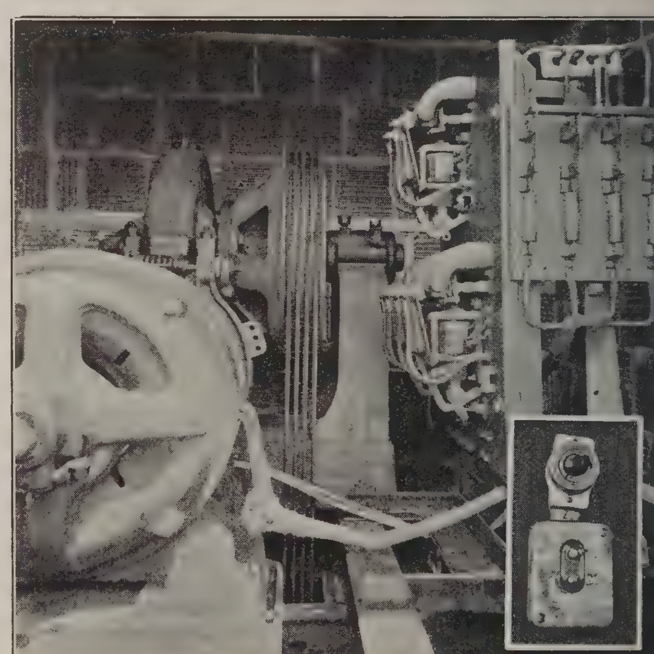
*See article in *Railway Electrical Engineer* for May, 1919, entitled, "A New Way of Loading Ocean Freighters."

Lighting Arrangement

It will be seen that construction is not entirely finished as temporary wires shown in the illustration are carrying current at the present time. The vacant space above the

Second Floor of Pier Showing the Three Lines of Lighting Units

two cut out cabinets, *B* and *C*, will be occupied by two balance coils for lighting. These balance coils will be supplied with energy from the box *A* on a 2-phase, 4-wire system, and will step down voltage to 110 and at the same time change to a 3-wire, 2-phase system. The circuits from the balance coils will enter into the cut out boxes, *B*



Apparatus in One of the Elevator Houses—Insert in Lower Right Corner Shows Push Buttons Which Are Mounted on the Wall of Each Car

and *C*, and from these cabinets to two safety switch panels, of which *D* is one. The safety cabinet *D* controls three lines of lighting fixtures, which extend down the center and either side of the pier to the fire wall, which is located about half way between the two ends of the pier. Con-

ductors lead from the cut box C to another safety switch cabinet similar to D, which is situated at the fire wall and controls the lighting at the other end of the pier. The type of lighting fixtures used is the Crouse-Hinds R. S. reflectors, and approximately 100 of these are installed for lighting the pier. The lighting arrangement just described is that which exists on the second floor of the pier, which is used as storage space. The same type of lighting fixtures is used on the track level on the floor below with the addition of Russell Stoll water-tight outlet plug receptacles mounted on every fourth post about 5 ft. above floor level. These receptacles are used for extending the lighting circuits into the cars or on the barges whenever it is necessary to furnish auxiliary lighting.

Elevators

Inasmuch as the second floor of the pier is used for storage purposes very largely, means have been provided

One of the Plug Receptacles Used for Extending Circuits into the Cars or Barges

for carrying material to these floors. The pier is equipped with eight elevators distributed over the floor space so that each elevator serves approximately the same area. The elevators used are made by the Sommerville Elevator Company. They are capable of lifting 4,000 lb. and travel at the rate of 75 feet per minute. For motive power, Westinghouse 2-phase, 4-wire, 220-volt, 15-hp. motors are used. These motors operate through a worm drive. The operation of the elevators is most simple and does not require an experienced operator. The control consists of two push buttons mounted in a suitable iron box on the side of the car. In conjunction with these buttons is also a porcelain indicating snap switch which can be used to cut off all power if desired. All that is necessary to operate the elevator is to push a button corresponding to the direction it is desired to move the car. When either floor is reached, as the case may be, the car stops automatically on a level with the floor.

The motors and automatic control device are located in the small elevator houses, which may be seen on the top of the pier. The power supply is brought up from the four 4/0 feeders, which are run just below the roof. These lines are led through the porcelain terminal block and thence through a 4-pole fused knife switch to the automatic control panel. This panel, which is made by the F. S. Payne Company, Cambridge, Mass., is equipped with type A reverse phase relays and a double pole circuit breaker, one pole being used in each of the two phases.

Fire Protection

The entire pier is equipped with a sprinkler system as a protection in case of fire. The particular type used is known as the dry system, the special feature of which is that the pipe line is filled at all times with compressed air. Should a fire occur at any point on the pier the nearest fusible plug in the line would melt and allow air to escape from the pipe. As soon as the air pressure drops water rushes into the line and is distributed over the area in which the fire occurs. In order to keep the line charged with air pressure at all times a small motor driven air compressor is used. The motor used for this purpose is a 3-hp. machine controlled through an automatic cut in switch which operates when the air pressure falls below the normal requirement of the pipe line.

The entire installation was installed under the supervision of George Eisenhauer, electrical engineer; George Hamilton, supervisor of electrical repairs; L. L. Dawson, chief electrician, and F. J. Hauck, assistant chief electrician.

British Electric Locomotives for Japanese Government Railways

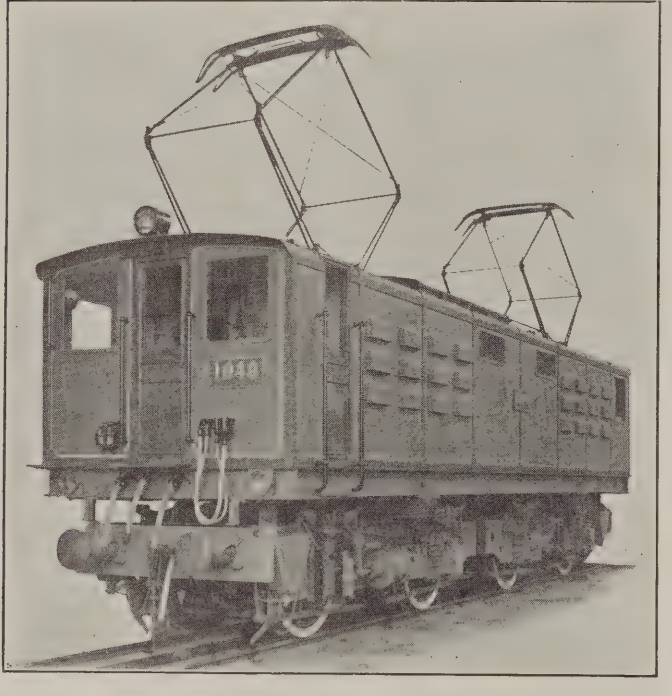
The English Electric Company is making deliveries on its order for 34 electric locomotives for the Imperial Japanese Government Railways. The first of these locomotives was shipped in February and the remainder will be completed by August.

Electric operation is no novelty in Japan. The main line from Tokyo to Yokohama, a distance of 19 miles, was electrified ten years ago, and the electric service on this line is at present being extended to the important naval base of Yokosuka. Electric trains also run on a high level loop line which connects four of the five main lines radiating from Tokyo, as well as on the suburban sections of those lines and on many privately owned railways. Apart from this the Japanese government is now converting to electric operation important sections of the main Tokaido line, which runs from Tokyo to the principal cities of Central Japan—Numadzu, Kyoto, Osaka and Kobe.

The physical and economic conditions which justify electrification are all present in Japan. Of the 6,600 miles of railway controlled by the state, the greater part is single track and the gage throughout is 3 ft. 6 in. Traffic is heavy and rapidly increasing. In 1920, 400,000,000 passengers and 56,000,000 long tons of freight were carried by the government lines. There are many steep gradients and sharp curves, and although in recent years great efforts have been made to improve the line, the nature of

the country traversed and in particular the large number of tunnels make any general doubling of the track difficult or impossible. Abundant sources of water-power offer an assurance of a cheap supply of electric current.

Before deciding on their program the Japanese Government Railways investigated the electric railway systems of the world and studied the designs of electrical equipment constructed by the principal manufacturers. As a result of this enquiry they determined to adopt a high tension direct current system, and in all future work direct current at 1,500 volts with a single overhead conductor will be employed. In 1921 the railway authorities ordered two 59-ton (ton equals 2,240 lb.) freight locomotives from each of four firms, two American, one Swiss and in England the English Electric Company. In June, 1922, a contract was placed with the English Electric Company for a further order of 34 electric locomotives, this being the whole number required to carry through the program of the Japanese government up to the end of 1923. The illustration shows one of the completed locomotives. This is the largest contract for electric locomotives which has yet been carried out entirely by British manufacturers. The mechanical parts of the locomotives have been built by the North British Locomotive Company at their works in Glasgow, Scotland, and the electrical equipment at the Dick Kerr works of the English Electric Company, where each locomotive is erected for inspection and test.



Illustrating a 59-Ton Freight Locomotive for 3 ft. 6 in. Gage Equipment With Four 306 hp. Motors and the English Electric Cam Shaft Control for a 1500-Volt D. C. System

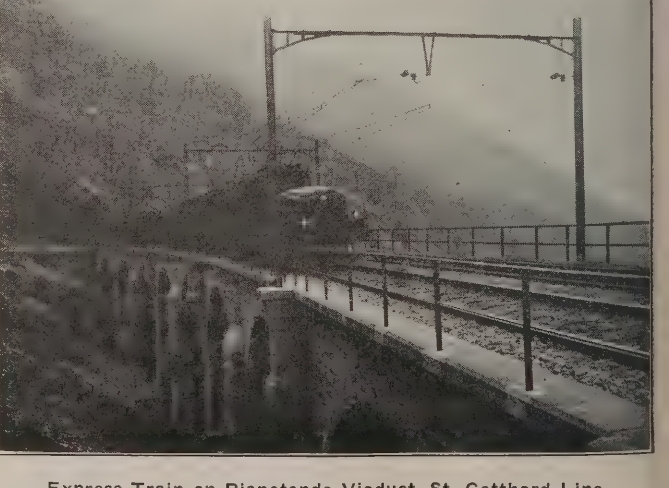
The locomotive illustrated is one of 17 which will be used entirely for freight service; 9 others are being built for hauling local passenger trains, and 8 of a heavier type for the express passenger service. The freight and local passenger locomotives are similar throughout except in the gear ratio, which is so adjusted as to give for the former a maximum speed of 40 miles an hour and for the latter one of 53 miles an hour. These locomotives are of the 0-4-4-0 type and weigh 59 long tons each. The weight is evenly distributed on the axles and comes just within the limit weight per axle of 15 metric tons enforced on the Japanese Government Railways. The aim which it has been sought to attain in the construction of the mechanical parts is to provide a sound and robust locomotive well-proportioned and of excellent finish, and generally to ensure that throughout the locomotives should represent the best British engineering practice. The locomotive trucks are articulated so that drawing and buffing stresses do not go through the superstructure. The monitor and part of the sides can be readily removed to allow erection and dismantling of motor generator sets and compressors.

Each locomotive is equipped with four motors each of 306 hp. arranged in groups of two in permanent series. The control is the "English Electric" electrically operated camshaft type, which provides series and parallel control and also two field shunting notches. The control is arranged for multiple unit operation so that two or more locomotives can, if necessary, be operated from one point.

The control voltage is 120 volts, which is obtained by means of the motor generator set and this set also drives the fans employed in the forced ventilation of the motors.

The pantagraphs are raised by air and are so arranged that any one of them can be raised or lowered independently of the others and that all the pantagraphs on a train can be raised or lowered simultaneously from any driving point. The locomotives are arranged with a driver's cab at each end and the center portion of the superstructure is occupied by the control equipment, air compressors and main resistances. All the high tension apparatus is in closed compartments and suitable interlocking is provided so that these compartments cannot be opened without the high tension apparatus being disconnected from the line. The locomotives are equipped with Westinghouse straight and automatic air brakes.

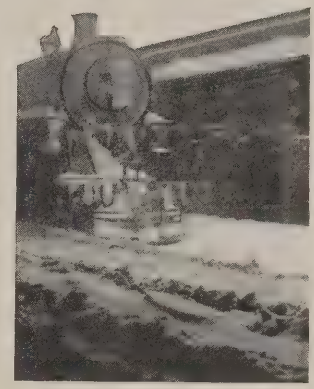
The eight express passenger locomotives are of the 4-6-6-4 type. The superstructure is mounted on two articulated trucks, each with a swiveling bogie and three driving axles. The locomotive weighs 96 long tons, there being 12 tons on each driving axle and 12 tons on each swiveling bogie. The electrical equipment includes 6 motors, each of 306 hp., the same motor being used as on the freight and local passenger locomotives. These motors are also arranged in groups of two in permanent series. In other details the equipment of these express locomotives is also similar to that of the type already described.



Express Train on Pianotondo Viaduct, St. Gotthard Line

Carlighting on the Canadian National Railways

Winter Time Maintenance ot Electrically Lighted Cars in Quebec Presents Difficulties Not Common in Latitudes Further South



By A. H. Matthews

WHEN the thermometer reads 20 below zero, we have car lighting in all its moods; and it doesn't have to be even 20 below to give us a variety, at that. It's a beautiful sensation to walk up a string of cars, open a battery door and find the cells lovingly tucked in a beautiful mantle of snow. You try in vain to get a reading on the hydrometer; it reads a little less than nothing, and there you are. Somehow or other we manage fairly well with the aid of the trusty (?) hydrometer syringe and a low reading voltmeter. We use the Weston type, with 5 volts low and 50 volts high reading, and this is very useful in taking the individual cell voltage, as well as the full battery voltage. For testing the car wiring and generator, we use the usual assortment that we happened to find lying around requiring a good home, and so, therefore, we have on hand the following for testing: Six dry cells, one test socket, consisting of a keyless socket with a yard of flexible cord attached, one bell, one telephone receiver, also with a yard of flexible cord attached one home-made current detector, and a few odd lengths of wire useful in testing. This is all the material we use for testing.

CAR	S. G.	VOLT	BELT	PULLEY	CHARGE A.V.	CHARGE T.	REMARKS March 21, 23
651	1160	18	R	✓	✓	✓	
960	1210	29-	O.K.	✓	✓	✓	3 Lamps B-0
801	1220	29-	O.K.	✓	✓	✓	
1420	1180	12	R	✓	40-50	7 8-3	Belt frozen
663	1215	29	O.K.	✓	✓	✓	Motored Generator
840	1240	31	O.K.	✓	✓	✓	

Fig. 1—A Sheet From the Note Book—Under Belt Heading, R Means Belt Repaired, N, New Belt Applied; Under Pulley Heading, the Check Mark Means Pulley O. K., N, Pulley Lost, R, Pulley Repaired; Under Charge Heading, A. V. Means Charging Rate, Amperes and Volts, and T, Hours Charged.

You will find it pays to have an orderly system of examining. This is how we do it. The specific-gravity is taken from one or more cells on each car, and as we go along the condition of each car is jotted down in a note-book, Fig. 1. After taking a reading from each car, the batteries which show a low specific-gravity are placed on charge, and the time and the charging rate is jotted in our note-book. Next, the voltage is taken. To do this all the lights are turned on full and left on two or three minutes. In the meantime, the reading lights, fans, bells, etc., can be inspected. The voltage reading is then taken and recorded. Incidentally when passing through the cars it is good policy to be on friendly terms with the conductor or porter in charge, for as these men are running the cars, they can generally give you some hints. For instance, the porter will say the lights seem to flicker. You turn them on and they look O. K.—voltage 'n' everything, but if the darky says she flicks, don't blame it on indigestion, but hunt up the trouble before it gets worse. It might be a leaky cell, a loose cell bolt, or a loose connection somewhere.

After taking the voltage readings as mentioned, the next thing we do is to inspect the axle pulley and belting, at the same time removing the dust cover from generator, giving it a rough inspection. When this is done any battery needing water is flushed, all repairs done being marked in our note-book for future reference. Twice a month the battery is overhauled; and once a month battery, generator and all inside fixtures are overhauled. To examine the generator the belt is first removed and the generator is motored. If it picks up O. K. and the car has been giving good service right along, then all you have to do is to see that the bearings are O. K., well greased, brushes O. K. and commutator clean. Clean commutator with a little gasoline and a clean rag. Don't use waste around a generator, and again, don't use too much sandpaper, it should only be used when commutator is burnt black. If the generator motors O. K. and picks up, and don't spark much, then the dust cover may be

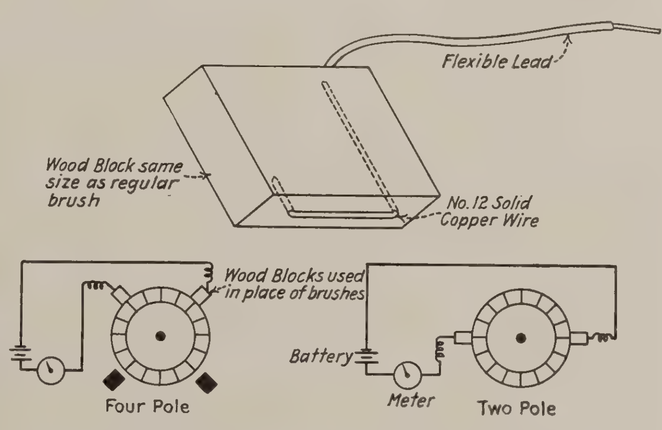


Fig. 2—Tests for Open Circuit—If Machine Has More Than Two Brushes, Connect the Leads to Two Adjoining Brushes and Raise the Others Off the Commutator.

put back again. In case the generator does not run well, I proceed as follows: First the belt is removed, dust cover taken off, brush holders cleaned out (an old tooth brush is handy for this), and brushes cleaned. See that the brushes work freely. After she is all spick and span we are ready for the test.

Four No. 6 dry cells are connected with the low voltage reading of our voltmeter, and two wood blocks of special construction used in place of the brushes. These blocks are used because some of the brushes span more than a single commutator segment. See arrangement in Fig. 2. Now the armature is slowly turned by hand, the deflection

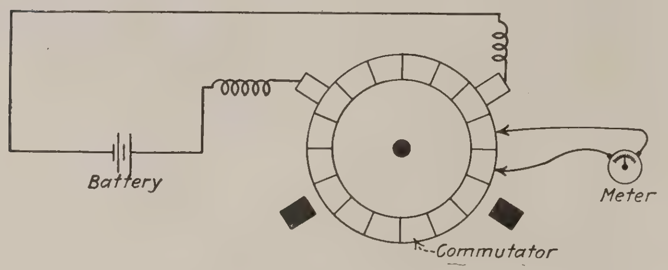


Fig. 3—Method of Taking the Voltage Drop Between Two Adjacent Commutator Bars

being noted as each segment is passed. If when on a segment there is no deflection, then the coil connected to this segment is open and must be repaired before allowing the car to leave. If on completely turning the armature around, the meter indicates no break, connect the cells directly to the blocks as shown in Fig. 3, and touch the meter connections to two adjacent segments, working from bar to bar. The deflection should be practically the same between any two segments. If the deflection shows a very large increase between two bars, it indicates a high-resistance in the coil or an open circuit. This test will also locate a short circuit by the absence of any deflection. If a short circuit is found, test every third segment as shown in Fig. 4. The normal deflection will be twice that between two adjacent segments until the coils

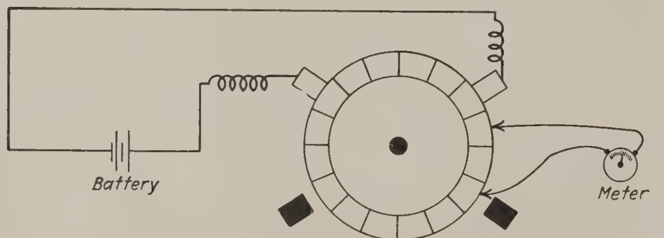


Fig. 4—Method of Taking Drop Between Two Alternate Commutator Bars

in fault are reached, when the deflection will be less. Then test each coil separately for trouble, and if they are O. K., the fault is between the two. Leaving the cells connected, connect one lead from the meter to ground (shaft or frame of the generator). Touch the other lead to commutator. If there is a deflection, there is a ground, in which case move the lead about the commutator, Fig. 5, until the least deflection is noted, and at or near this point will be found the fault. The field coils are now tested for ground, one lead from the meter being connected to ground, the other lead to the cells and field. If there is no deflection the coils are O. K., and now if everything is O. K. we are ready to make the final test.

At the generator regulator panel, connect the voltmeter across the generator leads, close the automatic switch and gradually bring the generator up to a very high speed. This is done by lifting the field resistance lever, which cuts in more resistance in the field, or in other words, weakens the field strength, letting the armature speed up. When the generator is running fast enough the lever is released. Watch the voltmeter when the auto switch cuts

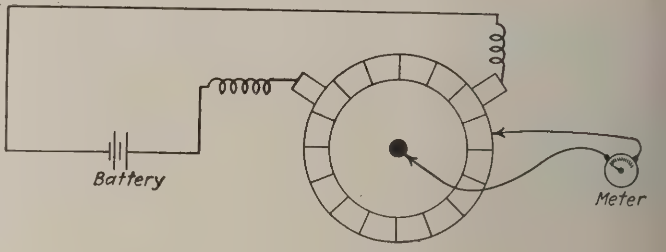


Fig. 5—Testing for Grounds

in; it should lift when the meter reads about four volts above the normal battery voltage. If it doesn't do so, first be sure that all contacts are clean as well as the carbon resistance. A paint brush is useful for dusting, together with a little elbow grease and some gasoline. Look over the dash pots and see that they work free without being loose, if everything is clean and the fuses are O. K., motor

YEARLY RECORD							1923
CAR	GREASED	BATT. WASHED	FLUSHED	V	SYSTEM	BELT LENGTH	REMARKS
2815	3-23	3-23	3-23	32	Safety, B	14'6" W.F.	
2793	3-23	3-23	2-23	32	U.S.L., T	9'10" W.F.	
1410	10-22 2-23	10-22	3-23	32	U.S.L., B	14'4" C.F.	

Fig. 6—Year Page From Journal—In This a Record of All Cars for the Year Is Kept

the machine again. If the switch still refuses to cut-in, adjust the resistance slider and adjust the dash pots, as by these adjustments it is quite possible to get the switch to cut-in at any voltage desired. After the generator is tested and O. K.'d, the suspension is oiled. We use coal oil for a few trips to keep the rust down.

The battery is next overhauled. We do this twice a month—a partial overhaul and a thorough overhaul. For

DAILY RECORD	
TRAIN NO.	March 15, 1923
45	663-OK, 838-OK, 4201-OK, 6503-OK,
33	Belfort-OK chg. 4 hrs, Brighton-OK chg. 4 hrs, 2858-1 lamp, 1420-OK,
51	957-OK, 958-OK, 2656-OK, 2621-OK,
11	1410-Rep. Belt, 802-Flushed chg. 3, 2612-Cut out 2 Cells, 801-Axle Pulley loose OK'd,
21	651-Flushed, 3 Lamps, 1425 Rep. Bells, 1453 Cleared short from section 7 Bells,
119	

Fig. 7—Daily Page From Journal—This Starts at Page 1 and Ends at Page 365—The Yearly Record is at the End of the Book, So That a Complete Record of Every Car Handled for the Year is All in One Book.

partial overhaul, the individual cell voltage is taken as well as the specific-gravity of each cell. For thorough overhaul, all the cells are pulled out from the box, specific-gravity and voltage taken, and the height of acid inspected. Cell covers are wiped off, connectors replaced where necessary and bolt tightened. In the winter, the

steam hose is passed over the cells to clear them of dirt and snow. The cells are then flushed with distilled or rain water.

For charging, we are using two motor generator sets consisting of one ten kw. unit, and one 18 kw. unit. Those feed five charging lines consisting of 27 charging receptacles in all. We use a standard length of 50 ft. for charging leads, which is long enough and not too heavy to pull around.

The greatest nuisance in winter is axle pulleys and

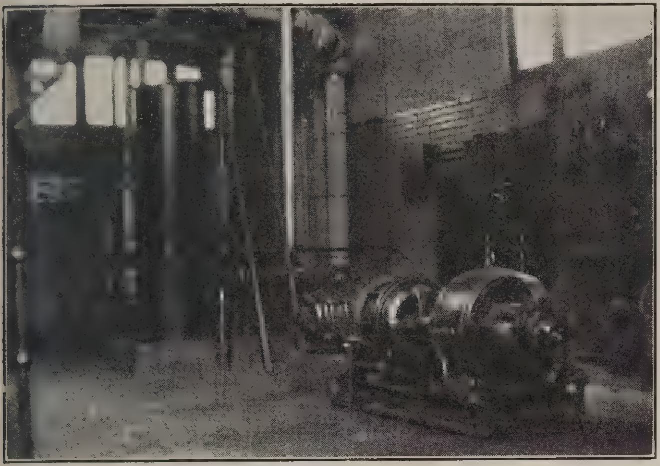


Fig. 8—Charging Sets and Switchboard

belts as the pulley gets piled up with snow which turns to ice and makes a splendid slipping surface! The belt also gets frozen up and gets so hard that it simply stands still. When it does make up its mind to do something it splits and cracks all over. About the only thing to do when the belt gets frozen over is to apply a new one, placing the frozen one in a warm place to thaw out. It is generally exchanged for the spare belt in car locker.

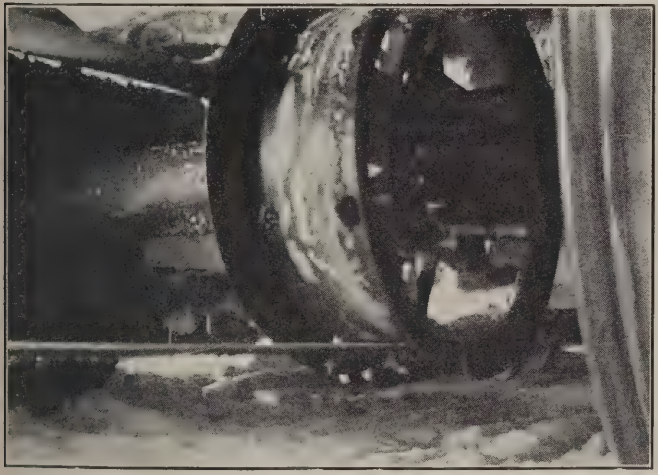


Fig. 9—A 22-inch Axle Pulley—The Pulley Gets Piled Up With Snow Which Turns to Ice and Makes a Splendid Slipping Surface

I think plain canvas belting is about the best obtainable. I applied a 4-ply, 4-in. canvas belt to a body hung safety generator, 20-in. axle pulley, 5-in. generator pulley belt, 14 ft. long with a Walker fastener. This particular belt gave good service for 12½ months, and in that time ran 150,000 miles. I removed this belt because the generator fell out of line and the belt turned up on one edge and split. There was a hard smooth surface on this belt. I have several cases on hand of canvas belts doing 100,000 miles, and for my part the canvas belt is best. When the axle pulleys get iced up we either use the steam hose to thaw them out, or hammer the ice off. Sometimes a little sand sprinkled on the belt helps.

The best recipe to keep down light failures is to do your bit, and help the other fellow. Don't knock. If there is something you can't do write a little note for the fellow at the next point, explaining as near as possible the trouble and put the note where he can see it. This saves time.

When testing storage batteries, carry in your vest pocket a small bottle of ammonia, and also a small bottle of olive oil, so that in case of an accidental splash of acid on the clothes, the immediate application of a small quantity of the ammonia will at once neutralize the acid and prevent it from burning a hole. If a splash of acid should go in your eye, wash at once with clean water, and then put one or two drops of the olive oil into the eye. I keep a record of all cars for my own use, and in this way I know what a car needs before I see it (nearly).

Education and Its Relation to Advancement

By Louis D. Moore
Electrical Engineer, Missouri Pacific Railroad

One of the most important things to be considered by a mechanic in preparing for advancement to higher positions is education. By this I do not mean "schooling" in the sense of going to school or college, excellent as is such training, as the term education is much broader than that. A man may be an excellent mechanic but be totally unfitted for either official or supervisory position because lack of education will not permit him to make out an intelligent report.

It is not necessary, as above stated, to go to school to obtain a very good education, as much can be done by reading at home. There are also two or three correspondence schools whose courses are first class, notably the International Correspondence Schools of Scranton, Pennsylvania, and the American Correspondence School at Chicago, besides the more advanced correspondence courses of several colleges. In addition there are night courses, both elementary and advanced, in various public and private schools and colleges.

A mistake that mechanics very often make is the neglect of the study of English. By English I mean correct speech, including grammar and spelling. A man in an official position or in a subordinate supervisory position should be able to talk and write correctly. Many men have schooled themselves in the proper use of English and there are a number of books to be had at the public libraries and by purchase which give correct forms to use and warn against incorrect forms. There are several magazines devoted to correct speech, also. A good dictionary of the intermediate size is valuable in this respect. One of the best at a moderate price is the small Standard Dictionary selling at about three dollars. Beware, however, of the cheap dictionary which is gotten up with a fancy back and colored pictures, selling usually "at the special price of 98 cents," as for the most part they are certainly not worth more than is charged for them.

Another phase of the matter of education is the study of the theoretical side of the particular trade in which the mechanic is engaged. It is not necessary to go to college to obtain a good working knowledge of the theory of electricity, for instance, and such a knowledge is absolutely essential to a man in a supervisory or official position in that line. It is not necessary to know the "high brow" side of the matter, although if a man desires to work harder in order to go that far, it is not only interesting but helpful. In order to understand properly electricity and mechanics above the most elementary stages, the knowledge of elementary algebra, geometry and trigonometry is necessary. It is absolutely essential that enough algebra be known to be able to solve simple equations, as practically all formulas are expressed in equations. Even the most fundamental formulas, Ohm's law and that for line drop, are thus expressed. A knowledge of involution and evolution (the powers and roots of numbers) is also essential.

There are a number of sets of books on the market which are exceptionally good, probably the best from the standpoint of home education being Croft's "Library of Practical Electricity," published by the McGraw-Hill Book Co. of New York. This set is particularly good because it is written so that the average craftsman can understand it and it also contains one volume on elementary mathematics which includes the elements of algebra, geometry and trigonometry.

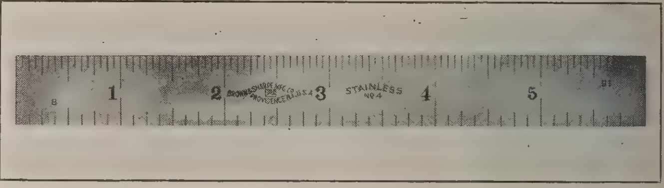
Another subject which is very desirable, if not absolutely essential, is drawing. A man should be able to make intelligible sketches even though he cannot make a finished drawing. There is nothing particularly complicated about ordinary drafting and here again much work can be done at home with simple equipment and a good instruction book. The instructions issued by the correspondence schools are excellent. There are also night classes in drafting at the various high schools, technical schools, trade schools and Y. M. C. A.'s. The advantage of going to some of these classes, even though at night, is that there is the incentive of class work which is not found in working alone. Incidentally, things are brought out sometimes by other students which may not have occurred to a single student at the time the question was asked but which might occur later when there would be no one to explain them.

A very important item is good handwriting. Without it an intelligent report is impossible. It can be practiced at home and at any spare moment anywhere without any particular instruction other than a set of copy letters. In fact, even these are not absolutely necessary.

The above matter of education should be of interest to craftsmen and subordinate officials or foremen alike for the reason that they are all potential officials. In other words, there is a chance for all to rise to a more or less official position provided each individual is prepared for such rise. Mechanics should, of course, perfect themselves as far as they can in the various branches mentioned, while those in supervisory capacities should fill in those subjects where they feel they are deficient.

Stainless Steel Rule

A stainless steel rule of special interest to mechanics, as well as a great number of foremen and other shopmen, has just been placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. This new rule is made of stainless steel so that it is rustproof and will not stain or discolor. Every shop man will appreciate the advantage of a rule which always retains its bright finish and thus eliminates the difficulty experienced in reading graduations on rules that have become rusty or blackened from use. The rule is made in 6-in. and 12-in. sizes and is graduated in 8ths, 16ths, 32nds and 64ths of an inch.



Brown & Sharpe 6-In. Stainless Steel Rule

The Cornish Riviera Express, Which Makes the Longest Non-Stop Run in the World, 226 Miles from London to Plymouth

Storage Battery Cars on the Canadian National

Cars Maintain Schedules Which Would Be Difficult for Steam Trains—Operating Costs Are Low

By E. B. Walker
Electrical Engineer, Canadian National Railways

THE first storage battery car operation on Canadian railways commenced on May 16, 1921, when car No. 15801 started an hourly service between Trenton, Ontario and Belleville more as a mechanical test than with any regard to traffic needs. The population of Belleville is 12,240 and of Trenton 5,500 and the distance between the towns is 11.4 miles.

When the service was started there were seven trains a day in each direction on the steam railways and a number of buses on the highway. Ten normal trips a day were made by the battery car with an additional round trip on Saturday.

The novelty of the service first attracted attention and brought sufficient traffic from the outset to pay expenses, but instead of decreasing as the novelty wore off it steadily increased until a month later there were often more than 500 revenue passengers a day. The schedule speed of this operation was 20 minutes for a single trip, including three to four intermediate stops, but we were able to make the trip in a minimum of 17 minutes. The Trenton-Belleville run was continued for a month with a reliability of performance that established the battery car as an entirely satisfactory operating unit.

On June 27, 1921, the car was started on a schedule run between Bathurst, New Brunswick and Campbellton, replacing a steam train. The distance between the towns is 63 miles and one round trip a day was made with about 18 intermediate stops. An interesting point to note here is that there were nine schedule stops and two flag stops when the service was started, but the ease in starting and stopping the car soon led to a gradual addition in the number of flag stops until a total of 18 was reached. The schedule allowed 2 hrs. and 50 min. for the trip, although it was found that this could easily be reduced to 2½ hours if necessary.

This operation was continued with remarkable reliability through winter and summer until September, 1922, when the car was removed to a new service between Toronto and Beaverton carrying passengers and milk. This run is 64 miles between terminals or 128 miles a day, and the schedule of 3 hrs. and 5 min. allows time for handling the milk which amounts to 120 cans on Monday morning.

Construction of the Car

The car body, built by Brill, is of simple construction as shown in the illustration. The underframe consists of two I-beams as centre sills and two channels as side sills with trussed cross members to carry the battery weight. The side posts are T-irons, on which 3/32 in. steel plates are riveted. The most important feature of the design is to obtain sufficient strength with a minimum of weight and the car designer must continually bear in mind that every extra ton means 3½ kw. hr. in battery capacity for a hundred mile run.

The trucks are Brill 69-E-2. They are of arch bar construction and are arranged for inside hung motors. The journal boxes are supplied with two Gurney ball bearings each. The Davis Steel wheels are 33 in. M.C.B. and are mounted on 4½ in. axles and have a wheel base of 5 ft. 6 in.

These trucks appear of light construction when compared with the type usually designed for interurban electric cars of similar size, but it must be remembered that the service is much easier than the usual rural

Car No. 15801 is Equipped with Four 25 hp. General Electric Motors, 2 Type K-36 Controllers, G. E. Straight and Automatic Air Brakes and Complete with Double Flooring, Storm Windows and Extra Battery, Box Lining, Weighs 33 Tons

trolley line with heavy grades and frequent stops.

In all cases the trucks gave entirely satisfactory service until we loaded 120 milk cans all at one end, which made it necessary to add another leaf to the elliptic springs and substitute heavier coil springs. The ball bearings have given no trouble whatever.

There are four General Electric 261-A-25 hp. 250/300-volt ball bearing motors mounted in the usual manner with gear ratio 16 to 91. This motor is developed from the G. E. 258 600-volt safety car motor. A standard series parallel controller and circuit breaker is installed at each end, and in the baggage compartment there are an ammeter, voltmeter, amperehour meter, underload circuit breaker and switches for the control of the battery compressor and lighting.

The storage battery consists of 250 cells of type A-12-H Edison assembled in trays of 5 cells each and arranged in the battery boxes under the floor, as shown in the illustration. The capacity of the battery is 450 ampere hours at an average of 300 volts or 135 kw. hr.

We have found it possible, however, to obtain 580 amp. hr. from these cells on emergency with a minimum of about 150 volts. This additional capacity has

End View of Car No. 15801

proved useful in winter when heavy snow drifts are encountered.

The lighting is furnished by ten of the main battery cells, which can be cut off from the power circuit by a double throw switch and consequently prevent the fluctuations in the power voltage from affecting the lights. The ten cells supply 12 volts for the 15-watt lamps inside the car as well as the two Golden Glow headlights, markers, classification, and number lamps.

General Electric straight and automatic air brakes are installed so that the car can be operated in any train, or can furnish air for one or two trailers. A motor driven compressor is installed in a compartment in the centre of one row of battery boxes and the usual air whistles, air operated locomotive bell, air sanders and hand brakes are also provided.

A Peter Smith forced draught hot air heater is installed in the baggage compartment and the fan motor is provided with a double throw switch giving full or half speed by means of a centre tap in the battery circuit.

Battery Charging

Direct current at 250 or 500 volts can be used for charging and the car is equipped with switches for ar-

End View of Car No. 15803

ranging the battery cells in either series or parallel, depending on the available voltage.

For the Trenton-Belleville run a 75-kilowatt 250 volt motor generator set, which was on hand, was temporarily installed near the station. This allowed charging at the normal rate of 90 amps. at night and gave sufficient capacity for three "boost" charges during the day of 150 amps. These figures are of course doubled with the battery connected in two groups in parallel.

For the Bathurst-Campbellton run the car was first charged at night at Bathurst only from a 75 kw. 250-volt motor generator set. We found, however, that when snow came there was insufficient battery capacity to make the round trip of 126 miles on a charge so the Trenton set was moved to Campbellton and the car recharged there during the lay-over.

For the Toronto-Beaverton run the car is charged at night from a motor generator set made from a 70-hp. 900 r.p.m. 60 cycle induction motor, coupled to a 50-hp. 500-volt direct current motor used as a generator. Dur-

ing the day it receives a boost charge from the 600 volt street railway circuit through a grid resistance.

For normal charging about 75 kw. should be available and 250 volts is preferable to 500 especially with a grounded circuit like a street railway. Mention is made of these different charging equipments to show that a variety of apparatus can be used.

The time required for a normal full charge is 5 to 7 hours, but higher rates can be used as long as the temperature of the battery does not exceed 115 deg. F. We have charged an empty battery in 2¼ hours with a maximum temperature of 106 deg. F.

Normal Operation

The car will usually travel about 140 miles on a full charge with normal grades, but it is wise to limit this to about 100 miles if possible or to arrange for a boost charge.

The consumption of power is about 35 watt hours per ton-mile under normal circumstances but head winds and snow may increase this considerably. Intelligent use of the coasting powers of the car will help materially in reducing power consumption. As an example of coasting, in the Toronto-Beaverton run there is a climb of 25 miles out of Toronto with an average grade of 0.577 per cent with long stretches of 0.75 per cent. The car climbs this at about 26 miles an hour, but on the return journey the entire 25 miles are made without power except for starting.

The acceleration is about ½ mile per hour per second and the speed on the level is about 40 miles an hour, but 48 miles an hour has been obtained with shunted fields. We have discontinued the use of shunted fields as the high speed is not necessary and the increase in current consumption is considerable.

As the car weighs about 30 tons unloaded the figure of 35 watt hours per ton-mile gives a consumption of 1.05 kw. hr. per car mile, which, of course, varies with the load, grades, windage, track conditions, etc.

In estimating the cost of charging current, 2½ to 3 kw. hr. per car mile should be allowed at the alternating current side of the charging set to allow for the above variation and for the battery and motor generator set inefficiencies.

Winter Operation

Fear was expressed that low winter temperatures would so reduce the capacity of the battery that operation would be unsatisfactory. We found, however, that the heat inertia of the large battery in well lagged compartments was quite sufficient to maintain reasonable temperatures when standing even in the coldest weather and during operations the temperature increased due to internal resistance losses.

As an example of our winter operating conditions I cannot do better than quote from a report made by the electrician in charge of the car:

"On Monday, January 23, we struck a very severe wind storm on trip west. The temperature was between 20 and 30 below zero. The snow drifted badly and some places the drifts were 3 feet high. Although the drifts were frozen hard we managed to get through them all successfully and caused great surprise at Campbellton, as it was not thought that the car would be able to get through. We arrived at Campbellton 30 minutes late, but as the local delayed us 14 minutes we were therefore only 16 minutes later than our running time; also we were 470 amp. hr. discharged. I notice the hard drifts bent the pilot slightly.

"At night we were badly blocked by limited and local, more especially the latter. The local I understand was finally pushed in by a freight as the water pipe between tender and engine got frozen. We arrived at Bathurst one hour and 35 minutes late, but actually we made up time.

"The temeprature is still remaining around 20 below, but we are making our running time O. K. Last night we were blocked 27 minutes by limited at Eel River, but we arrived at Bathurst on time."

Throughout this winter the car has operated without a failure between Toronto and Beaverton, although the snow has been unusually heavy.

Trailer Operation

The car has a tractive effort of about 2,400 lb. at the one hour rate. As an experiment it easily pulled a trailing load of 208,000 lb., although it is not intended for such service.

Car No. 15802 is Equipped with Four Westinghouse V-65-A3-250 Volt Ball Bearing Motors, Gear Ratio 15 to 91, Mounted on Brill 69-E Trucks with S. K. F. Bearings

On one occasion we pulled a 25-ton trailer with ordinary bearings from Bathurst to Campbellton, making all stops; there was no difficulty in maintaining schedule and we were able to make up 10 minutes lost waiting for a meet.

At the end of the run the battery was 450 amp. hr. discharged and the temperature of the commutators was only 85 deg. F. with an outside temperature of 60 deg. F. This shows that the motors are of ample capacity for a trailer, although it would be advisable to equip the trailer with ball bearings and make it as light as possible, as the miles per charge are almost proportional to the weight.

A better type of two-car train consists of two battery cars with multiple unit control.

Battery Maintenance

The Edison battery is easy to look after if the cells are kept clean and dry and flushed regularly with

distilled water. They lose capacity if not in service but a cycle or two of charge and discharge will soon bring them back to normal. Overcharges at high rates every week or two seem to keep the battery voltage at a higher average than can be obtained by the normal charge only.

The maximum life of the cells is difficult to ascertain. The battery on car No. 15801 is five years old and is over the rated capacity; we also have cells which have been 10 years in this class of service and which give full catalogue rating. It seems safe to estimate a useful life of at least 8 to 10 years with normal care and conditions.

Cost of Operation

The cost of operation varies so greatly with local conditions, cost of electric power, wages, etc., that no general figure can be given, but it is easy to estimate the cost for any particular operation from the following:

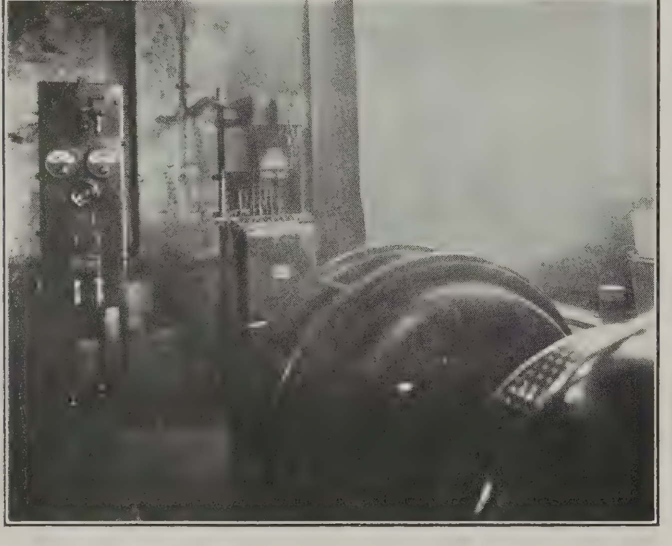
(1) Electric power should be estimated at 2½ to 3 kw. hr. per car mile (30-ton car) at the alternating current side of the charging set.

(2) Wages of crew will have to be added according to local conditions.

(3) The partial services of an electrician for flushing the batteries, and inspection will be required.

(4) Car maintenance and supplies, this should be from 2 to 3 cents per car mile.

(5) Depreciation should be included at 10 per cent



Very Simple Equipment is Required for Charging the Car Batteries

for the battery and 5 per cent for the car body an motors.

(6) Interest.

Failures

Since the car was put in operation there have been two interruptions due to electrical defects and three or four due to insufficient charging.

The first electrical trouble was caused by a trailing lead rubbing on the armature of one of the motors which caused a burn-out. The car operated in an entirely satisfactory manner for two or three weeks with one motor cut out while the armature was being repaired.

The second electrical trouble was caused by a grounded cell while charging from the 600 volt street railway system. We do not know what started the ground, but suspect that it was due to careless flushing. The result was that the grounded cell punctured and spilled the electrolyte, which caused other cells to ground. Three cells in all were injured in two different trays. Seeing smoke from the battery compartment the yardmaster cancelled the run and sent out a steam train, although, had the electrician been advised in time, it would have been a simple matter to cut out the injured cells and operate the car as usual, which was actually done for the next day's run.

The charging failures were mostly due to an old

Car No. 15803 is Equipped with Four 21 hp. Westinghouse Motors, 2 Type K-35 Controllers, Westinghouse Air Brakes with Emergency Feature and Weighs 25 Tons

steam driven generator at Campbellton, which broke down more than once, which resulted in the installation of the motor generator set referred to elsewhere.

The only other charging failure was due to somebody who turned the ampere hour meter back to zero by hand, with the result that the charge was shut off before completion.

Battery Cars Now in Service

Car No. 15800 is an old gas electric car which is being remodeled. The body is of steel of similar construction to that already described, but it is 60 ft. long by 10 ft. wide and the seats will hold three abreast. The baggage and engine compartments are being cleared out and fitted with seats as a smoking compartment, giving a total seating capacity of about one hundred. The car will be put in service between Winnipeg and Transcona, a distance of about seven miles, making seven round trips per day.

Ball bearing trucks with 33-in. rolled steel wheels will be applied and the electric equipment will be identical with that described above. The battery will consist of 260 cells of A-12-H Edison and will be charged in parallel from the 250-volt d. c. shop circuit at Transcona.

Car No. 15801 is our first car, supplied by the Railway Storage Battery Car Company, and described above. The seats in the smoking compartment shown in the illustration have been removed to give sufficient

room for the milk cans, service between Toronto and Beaverton will be continued.

Car No. 15802 is a Brill car similar to No. 15801 but slightly shorter. It seats 30 in the main compartment and 20 in the smoker and has a 10-ft. baggage compartment. It is equipped with four Westinghouse V-65-A3-250-volt ball bearing motors, gear ratio 15 to 91, mounted on Brill 69-E trucks with S.K.F. bearings, and 30-in. chilled iron wheels. This is a similar truck to the 69-E-2, but the wheel base is 4 ft. 6 in. instead of 5 ft. 6 in. and the motors are outside hung. Westinghouse air brakes and compressor are installed, Peter Smith heater and other details similar to car No. 15801. The battery consists of 270 cells of A-12-H Edison. This car will be put in service on the Bathurst-Campbellton run formerly furnished by car No. 15801.

Car No. 15803 is of identical construction to No. 15802, but it is only 36 ft. 6 in. long, over end sills and seats 30 passengers in the main compartment and with a few folding seats for smokers in the baggage compartment. The motors and trucks are identical with car No. 15802, but the gear ratio is 22 to 84 to allow the use of a lower voltage battery. The battery consists of 110 cells of M V X-33 Iron Clad Exide battery. Half of the cells are under the seats and the remainder are in the usual battery compartments under the floor. This battery has a capacity of 544 amp. hr. at an average of 215 volts or 117 kw. hr.

It is in service between Brockville and Westport and runs 107 miles per day on one charge. The grades on this section are heavy and reach a maximum of 1.77 per cent.

The car is charged at night from a motor generator set in the Brockville roundhouse. The set has a capacity of 57 kilowatts at 275 volts and the battery is charged with all cells in series. By charging at night only, advantage is taken of the off peak power rate, which is 35 per cent less than the day rate.

Car No. 15804 is under construction at our St. Catharines shops and will be 60 ft. long to seat 60 with a 10-ft. baggage compartment. The electrical equipment will be identical with car No. 15800. No run has yet been assigned to this car.

Comparison of Batteries

Comparison of the relative merits of the nickle-iron and lead batteries have been made very fully by various authorities and it is not necessary to go over this again.

In brief, we have found that the nickle-iron battery will stand rough usage and give long life in battery car service and we are waiting with interest to compare results with the lead battery on car No. 15803.

The longer life of the nickle-iron battery is partially offset by the lower price and high efficiency of the lead battery, which, however, has its drawbacks of greater weight; only by experience and careful records can we obtain an accurate comparison.

Automatic Train Control Developments

Increasing Activities Are Manifested by the Appearance of Many New and Improved Devices

The General Railway Signal Company Automatic Train Control

THE General Railway Signal Company has made several important developments in its train control equipment during the past few months. The information in this article does not cover the entire train control system of this company, but is considered as supplementary to the article published on pages 95 to 97, inclusive, of the March, 1922, issue of the *Railway Electrical Engineer*. Developments which have since been made in the speed control equipment, as being installed on the Chicago & North Western and other roads, is described in detail below.

This is a system designed to limit the speed of a train to any degree at any point. The fundamental principle consists of a time element device on the locomotive, operating in combination with pairs of inductors placed along the right of way, the spacing of the inductors determining the speed at which a train may pass the point in question without an automatic application of the brakes. The closer the spacing, the lower must be the speed, while greater spacing permits of higher speeds.

Circuit plans, Figs. 1, 2 and 3 illustrate the principles involved. The control is transmitted from the right of way on to the train through the medium of the receiver in the manner described in the March, 1922, *Railway Electrical Engineer*, Fig. 1, page 95.

Relays Are Controlled By Balance Wheel

Upon passing an inductor on open circuit, as shown in Fig. 1, herewith, relay R^1 is opened, as indicated by the dotted line. This, in turn, de-energizes the secondary relay R^2 which in turn de-energizes magnet D; this then allows the balance wheel E, impelled by the spiral spring F and kick-off spring G, to swing approximately 270 degrees. In doing this the spiral spring first unwinds and then winds up in the opposite direction, prepared to cause the balance wheel to swing back to a position closely aproximating its position of rest, as shown in the drawing; in fact, far enough to be under the influence of magnet D which in the meantime has become re-energized.

This balance wheel is of the same principle as the balance wheel in a watch, on which the accuracy of the timing of a watch is based. It is found that the time of the swing of this balance wheel is very accurate under extreme variations of temperature and shock and is independent of the battery voltage or other conditions.

As soon as the balance wheel starts rotating and armature H is away from the influence of magnet D, a contact JK, operated by the shaft of the balance wheel E, is made. The making of this contact then picks up relays R^1 and R^2 and re-energizes magnet D. The entire cycle takes place before contact BL is broken. This contact

BL likewise being operated by the shaft of balance wheel *E*.

It will be noticed that relay R^3, which in turn directly controls the electro-pneumatic valve, is fed through two circuits, namely, *BLM* through its stick contact to common, and also BR^2M likewise through the stick to common. In order, therefore, that relay R^3 may drop and cause the application of the brakes, it is necessary to have both the circuits *BLM* and BR^2M open simultaneously. As stated above, the first impulse transmitted to relay R^1, starts the time element device *E* in operation, but the relay R^1 is picked up and the circuit BR^2M is made before the circuit *BLM* is opened and therefore relay R^3 is not de-energized. If, however, before reaching the next pair of inductors, the swing of balance wheel *E* has not been completed, circuit *BLM* will not be made and the opening of R^1 will deprive relay R^3 of current, therefore it drops and the air brakes are applied.

If, however, the train speed was such that upon reaching the second of a pair of inductors, the time element device *E* had completed its swing and closed circuit *BLM*, then the opening of relay R^1 would not deprive R^3 of current, and there would be no application of the brakes. In other words, given a pair of inductors on the right of way, if a train passes from one inductor to the other and consumes the proper amount of time there will be no brake application, but if it operates too rapidly there will be a brake application. The arrangement shown is accurate to within a fraction of 1 mile an hour. The system in principle is perhaps more clearly illustrated by Figs. 2 and 3, the relay and contact designation being the same as in Fig. 1. It will be noticed that in Fig. 2 the

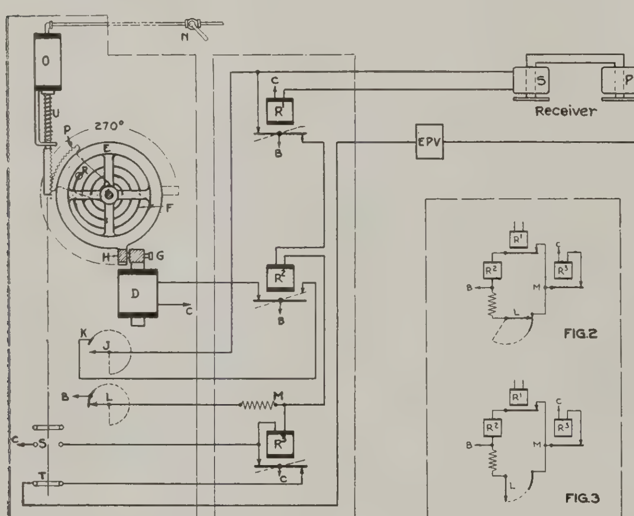


FIG. 1

Figs. 1, 2 and 3, Diagram of the Apparatus and Circuit Connections on the Locomotive

relay R^3, which in turn directly controls the electro-pneumatic valve, is a stick device controlled through two multiple paths BR^2M and *BLM*. Passing the first inductor opens relay R^1 and thereby starts the contact *L* in operation. Relay R^1, however, being reset or picked up again before contact *L* opens its circuit does not deprive relay R^3 of current. If, however, as shown in Fig. 3, contact *L* is open when the next inductor is reached, the opening of relay R^1 will deprive relay R^3 of current which will drop, and remain open until it is manually restored.

Assuming the application of the brakes to have taken place, the train must stop in order that the engineman or fireman may dismount and effect the reset. The resetting is done through pneumatic means by operating valve handle *N*, Fig. 1. Operating this handle introduces air to a cylinder *O*, which operates a rack and in turn the sector *P*. The outer end of the spiral spring *F* being attached at *R* to this sector, is the medium through which the wheel *E* is caused to swing up against magnet *D*, as a result of the operation of cylinder *O*. In normal operation, the sector *P* remains stationary, the balance wheel *E* operating independently of it.

It should be understood that subsequent to receiving

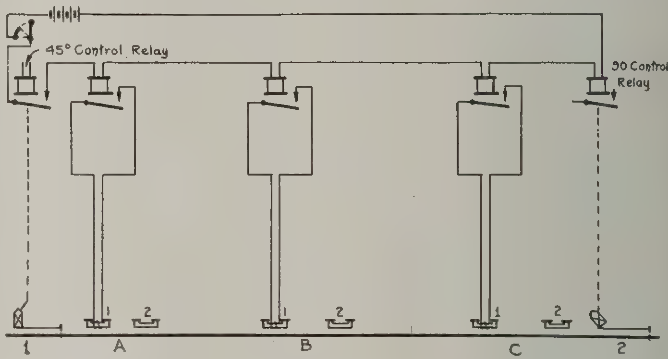


Fig. 4, Wayside Circuit Showing Connections with Signaling System

the automatic application of the brakes, the balance wheel *E* will swing back and forth, finally coming to rest in a mid-position, and that therefore some means must be provided, controllable from a remote point, to push armature *H* up against magnet *D* in order that the system may be reset conveniently, and furthermore, relays R^1, R^2 and R^3, all having been de-energized, will likewise have to be picked up. This whole operation is effected through the medium of the cylinder *O*. This cylinder, in addition to moving armature *H* up against magnet *D*, will, on its way over, momentarily close contact *JK* through the medium of balance wheel *E*, which in turn will pick up relays *R* and R^2, thereby re-energizing magnet *D*, which in turn will hold armature *H* when it is pushed up against the magnet by the action of the cylinder. When the cylinder is clear over, contact *S* is closed, which picks up relay R^3, thus completing the reset.

In order to be sure that valve *N* will not be left in the reset position, thereby cutting out the train control, a contact *T* is operated by the cylinder *O* which takes current off the electro-pneumatic valve, thereby putting on the brakes. The brakes remain on until, and unless, handle *N* is moved back to its normal position, thereby permitting the spring *U* to push the piston, rack *P* and spring support *R*, back to normal, after which the *EPV* becomes energized by the closing of the contact *T* and train operation may be resumed.

Tapered Speed Controlled By Spacing of Inductors

Fig. 4 shows the wayside circuit, together with a set of inductors designed to force the speed of a train down to a very low point before it reaches the stop signal. In other words, it is the "tapered speed control" application to the system of intermittent inductive control.

A pair of inductors *A*, is placed near the signal and close together, so that if signal 1 is at stop, the speed of a

train speed at this point than at *B,* without causing an automatic application of the brakes. A pair of inductors *B,* is placed further back and further apart, necessitating that the speed of the train at this point be below a certain rate which is higher than that imposed by inductors *A.* Likewise, a pair of inductors *C,* is placed still further back and spaced further apart, which permits a higher train speed at this point than at *B,* without causing an automatic application. Pair *C* is placed braking distance away from signal 1, based on the equipment most difficult to stop. Therefore, a train approaching signal 1 at stop, must be governed by the caution signal 2 and must reduce speed properly to avoid being stopped.

The inductor 1 of each pair has a winding controlled

Fig. 5, An Inductor Clamped to the Rails

by a line relay in series with the 90 degrees control relay, this relay being closed whenever signal 1 is at caution and the block ahead unoccupied. When the circuit is closed, inductor 1 has no influence on the train control apparatus and therefore only a single impulse will be received on passing any pair of inductors, thus resulting in only a single swing of the time element device and therefore no application of the brakes will result at any speed. If it is desired to provide a fixed speed limit, it becomes necessary only to install a pair of inductors, neither of them having windings. A train passing this point must therefore always be under the speed determined by the spacing of these inductors in order to avoid an automatic stop. By this means the normal speed of a train can be limited to any desired amount at any point and a fixed speed restriction may be enforced wherever desired.

Provision for Difference In Speeds of Freight or Passenger Trains

Referring again to the balance wheel of the time element device, it will be noted that if this wheel is weighted in some manner, that it will swing more slowly. This is actually provided for by means of a magnet which holds a ring in suspension. A tongue is on this ring and there is a groove on the balance wheel, *E.* When the magnet is de-energized, the ring will drop on to the balance wheel *E* and thereby increase its inertia, resulting in a slower swing; use is made of this to provide for the lower speeds of freight trains. By opening a circuit the proper speed control for freight trains is made effective and by closing the circuit, provision for passenger train speed control is effected. In other words, if a passenger train is limited to 60 m.p.h. at a given point, freight trains could be limited to 35 m.p.h. It should be noted further that the normal speed limit may be varied to suit local conditions. For example, if there is a momentum grade, freight trains may be permitted to "spurt" when approaching the grade, in order to avoid the necessity of reducing tonnage, increasing power or using helpers, etc., and this may be done without improperly raising the speed limit at other points.

Inasmuch as it is a very simple matter to clamp a pair of inductors to the running rails, temporary speed restrictions can be enforced easily and held in force until such time as the inductors are removed or respaced. By the use of three inductors together, two wound and one unwound and by suitable selecting means for the wound inductor, three different speed limits may be provided for, or the speed limit may be eliminated entirely with both circuits closed.

Fundamental Parts Described In Detail

An inductor in place clamped to the running rails by means of insulated cross members is shown in Fig. 5. The housing is in a single manganese steel casting with the inductor magnetic circuit and coil mounted inside it. Fig. 7 shows the relay box with the relays and time element device as called for by the circuit plan Fig. 1. The three relays are mounted on a common bakelite base protected by a sealed cover with a glass opening. The

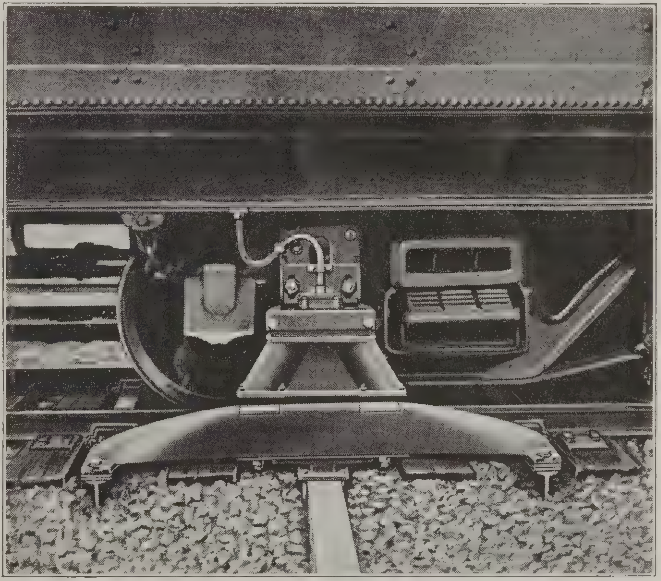


Fig. 6, A Receiving Element on a Locomotive, Standing Over An Inductor on the Track

photograph also shows the top view of the time element device and through the opening in the plate, the holding coils *M,* Fig. 1 and air cylinder *O,* of Fig. 1. The terminal board shown at the lower right-hand corner of the inner housing is provided to receive the incoming cable. The relays, time element device and terminal board are all mounted on a common cast iron base held by four screws. Therefore, it is necessary only to remove the four screws and disconnect the cable and the air connection in order to remove the entire relay and time element unit. It will be noticed that there is an inner and an outer housing, the inner housing being floated against the effect of friction in all directions, to cause it to ride without severe jar or shock. The relays

and time element device are separately covered and are inside of the containing box, which in turn is held within the outer box. Two dead air spaces are provided in order to eliminate condensation or moisture occurring on the operating parts.

The electro-pneumatic valve is shown in Fig. 8. The coil of this valve will be seen by reference to circuit plan, Fig. 1. It will be observed that the main frame is independent of the valve chamber below and of the casing above. This construction permits the removal of the valve chamber for inspection, without disconnecting the pipes. The valve may be located high in the air-brake system and kept warm so that there is little possibility of moisture collecting in the valve; should any collect, it could not freeze. It is well known that water and moisture may be present in almost any part of an air-brake system, and if it is in an exposed position to the cold, it is quite likely to freeze.

The brake valve handle actuator in place is shown in Fig. 9. This actuator has two cylinders with differential pistons, the small cylinder is fed by air direct and the large cylinder is fed by air through the medium of the electro-pneumatic valve. When the electro-pneumatic valve is open, the small cylinder pushes the piston over and causes a brake application. When the electro-pneumatic valve is closed, the large cylinder receives air, and overcoming the small cylinder, releases the automatic application. The initial movement of the piston, as the result of an automatic brake application, disconnects the handle from the valve proper so that a full service application of the brake is applied, irrespective of anything the engineman can do.

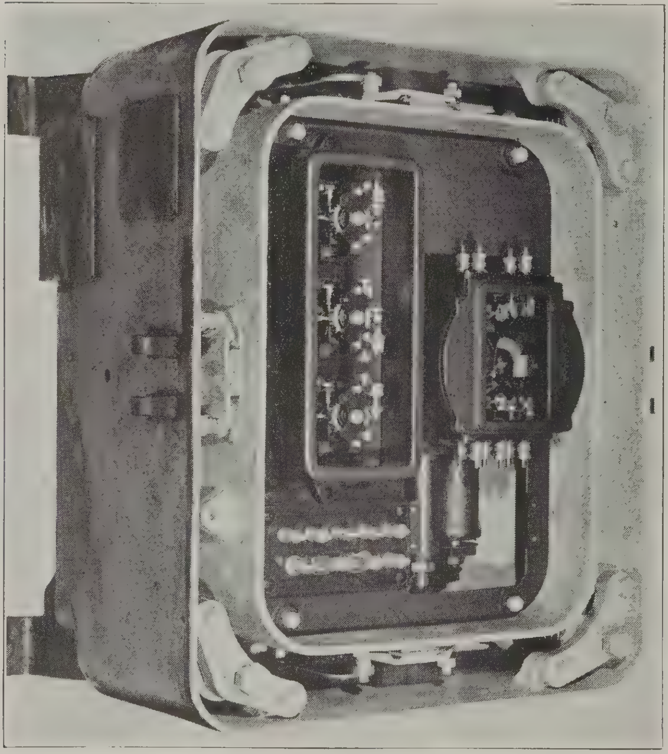


Fig. 7. Box with Relays and Time Element Device

When the automatic application is released, it becomes necessary for the engineman merely to move his valve handle to the service position, at which time the handle and valve become reconnected and the brakes can be controlled in a normal manner. The system does not prevent the engineman making an emergency application if necessary.

In applying this device, it is necessary to remove only the brake valve handle and assemble the actuator with its handle in place. In other words, it is not necessary to do anything to modify the internal construction of the air brake apparatus in any degree.

By the application of a small device (not shown) on the top of the actuator, which can be set and locked in either the "freight" or "passenger" position, it becomes possible, as the result of an automatic application of the brakes, for the valve to be disconnected from the brake valve handle for passenger service, as explained above, but for freight service the valve is not disconnected from the brake valve handle. This arrangement, when set in the "freight" position, permits the engineman, by exerting pressure against the brake valve handle, to modify an automatic application. This action may be very desirable in case the automatic application should come on at a time, place and under loading conditions, which might result in a buckled train. This attachment gives the engineman an opportunity to regain control of the brakes in case the application may result seriously. This feature is optional and may be provided, or not, as required.

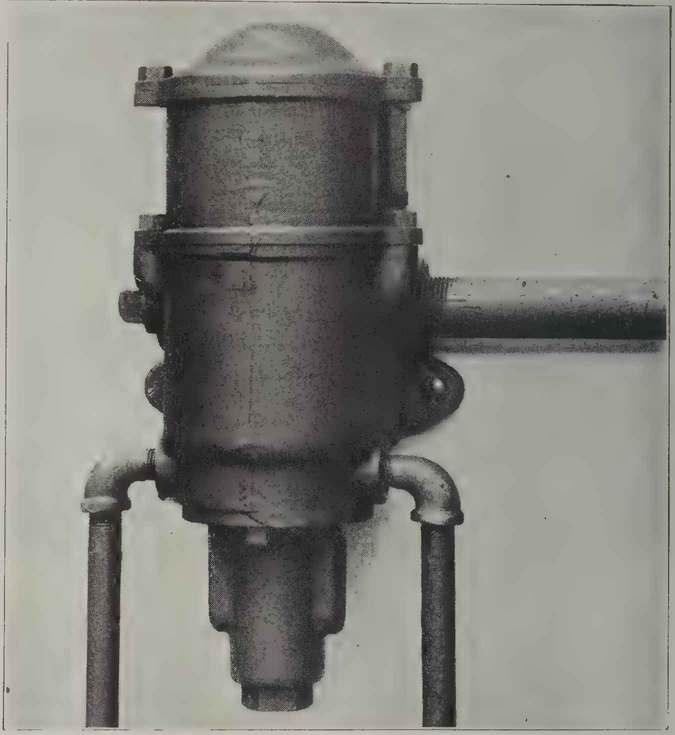


Fig. 8. The Electro-Pneumatic Valve May Be Taken Apart Readily

Summary of the Advantages Claimed

In conclusion, the following features are claimed for this system as described above:

1. A means is provided of limiting the speed of a train to any desired rate at any point.

2. A means is provided for eliminating the control automatically at a given point or making it effective, depending on the conditions ahead, or the speed control can be left effective at all times, thereby providing a fixed speed limit.

3. A way is provided for controlling the speed of freight and passenger trains. This is an important feature because if it were impossible to control the trains differently, then the passenger trains would have to be limited to freight train speeds, or freight trains would have no control. The limiting of normal speeds becomes desirable where the maximum speed which a train can attain is much higher than the speed for which the system is installed. For example, if a system is installed, based on 60 m.p.h. for passenger trains, and a train should be running at 80 m.p.h., the braking distance would be so much greater that protection would be largely lost or greatly reduced. By having the controlled speed for freight and passenger trains different, there is a greater efficiency in tapering down train speed on approaching a stop signal.

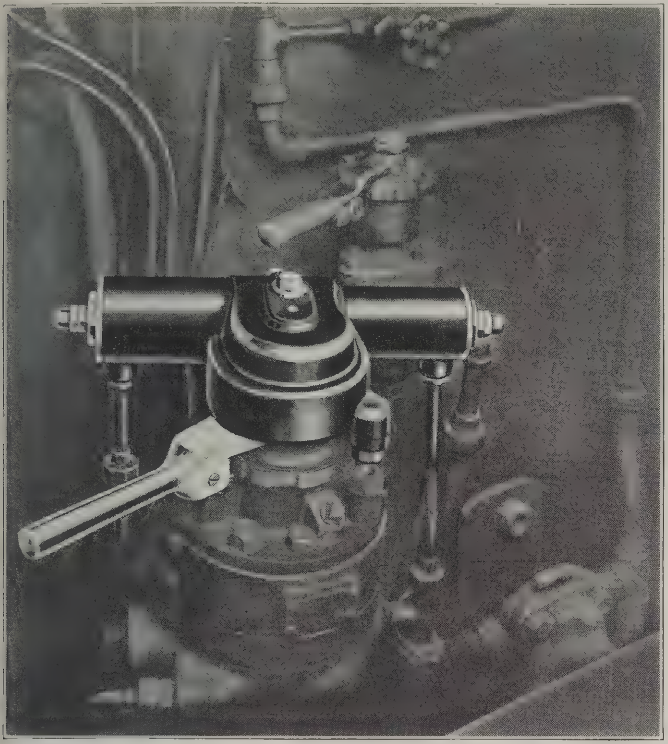


Fig. 9. The Brake Handle Actuator in Place on the Engineman's Brake Valve

4. By placing a pair of inductors close together, the system becomes, in effect, an automatic stop effective at very low speeds. In this connection it often happens, especially on double track, that a system may be reconnected to give a full block overlap without materially influencing traffic capacity. In such a case it becomes necessary to use only one pair of inductors, which are placed at the signal in order to obtain full protection, and this permits a train to move up to its stop signal without interference. The system may be used as a simple automatic stop or can be converted into tapered control at any point on the line by the use of two or more pairs of inductors. Thus with the same engine equipment the wayside apparatus may be installed so as to give anything from a simple automatic stop up to full tapered speed control.

5. In passing through a caution block, if an engineman reduces the speed of his train properly the train control will not act and therefore the train is permitted to resume normal speed should the signal next in advance assume a less restrictive position.

6. No manual operation other than that now performed by an engineman is necessary in making a movement against traffic or into or out of unequipped territory.

7. By the use of an automatic reversing switch and an extra receiver on the engine, trains can operate either forward or backward under protection of the train control.

The Indiana Equipment Corporation System of Train Control

THE Indiana Equipment Corporation's system of train control is of the intermittent electrical contact type and is designated as the I. E. C. Train Control System. The system has been designed and developed by C. F. Shadle, as chief engineer, who was formerly signal and efficiency engineer of the Cincinnati, Indianapolis & Western and who designed the Shadle Automatic Train Signal and Stop, which was installed six years ago and is still in service on a portion of the C., I. & W.

The essential parts of the locomotive equipment are the shoe housing and shoe, the automatic brake valve, the control relay and the speed controller. The roadway equipment consists of an 80-ft. ramp connected with and controlled by the block signal circuits. Provision has been made for the installation of visual or audible or both types of signals in the cab. The system has been designed with the idea of its being an adjunct to existing block signals, its primary function being to enforce obedience to fixed signal indications and to leave the control of the train in the hands of the engineman as long as he acts to handle his train properly. The speed controller is designed as an adjunct to the automatic stop feature of the device so that should it be accidentally broken or otherwise be put out of commission it can be cut out and the train proceed under the protection of the automatic stop.

Operation of Brake System

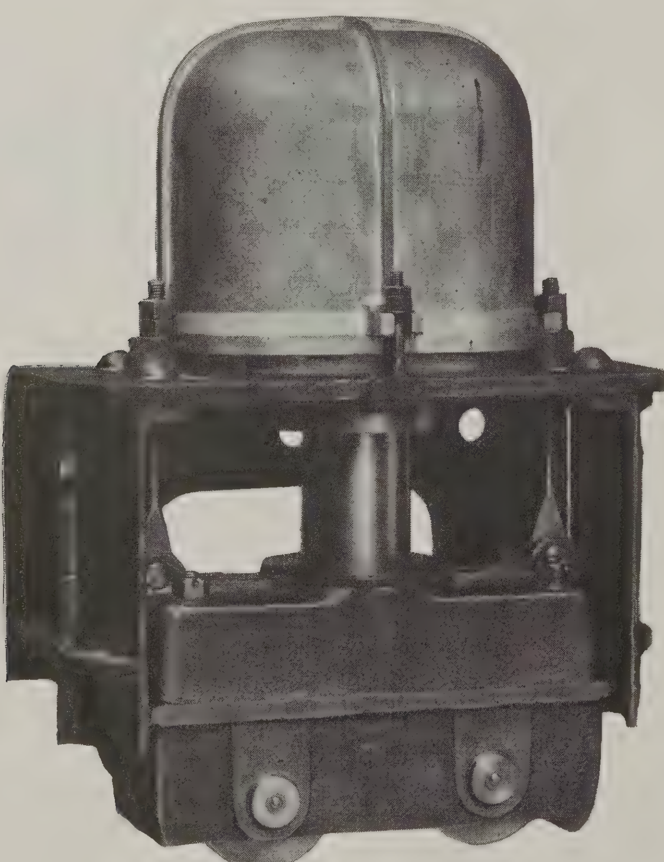
The automatic brake valve is of the slide valve type following standard air brake construction. It accomplishes the required gradual brake pipe reduction according to the speed of the train under the dual control of the speed governor and the electro-pneumatic valve. In action, this valve makes a gradual reduction of brake pipe air pressure in order to prevent the quick action of the brake and follows this with a gradual stoppage of the brake pipe exhaust. The valve was designed with a view of making an automatic service application of the brake to approximate that of hand operation by the engineman of the engineman's brake valve. The valve makes a required brake pipe reduction and laps the valve to hold the brake on the engine and on the train. This automatic valve does not prevent the engineman from operating his regular brake equipment or interfere with hand braking. However, should the engineman make a light brake pipe reduction, the automatic brake valve will

complete the operation subject to the action of the speed controller. The engineman can hold the brakes on the engine and recharge his train without interference from the automatic valve. If the engineman operates a release switch, which is provided for that purpose, an automatic release of the brakes and the recharging of the train braking system will take place when the train speed has been reduced to the predetermined safe speed limit.

A train traveling at any speed on entering a caution or stop block will receive a full service application of the brakes unless the engineman operates the control switch in the cab. The operation of this switch will set up the speed control to govern the brake application according to the speed of the train and it will prevent a brake application if the train is traveling within the low speed limit. Should the engineman fail to operate this switch the train will come to a full stop. When two or more engines are coupled together the brake control is cut out of service on all engines except the first one by means of closing the brake pipe double-heading valve in the brake system.

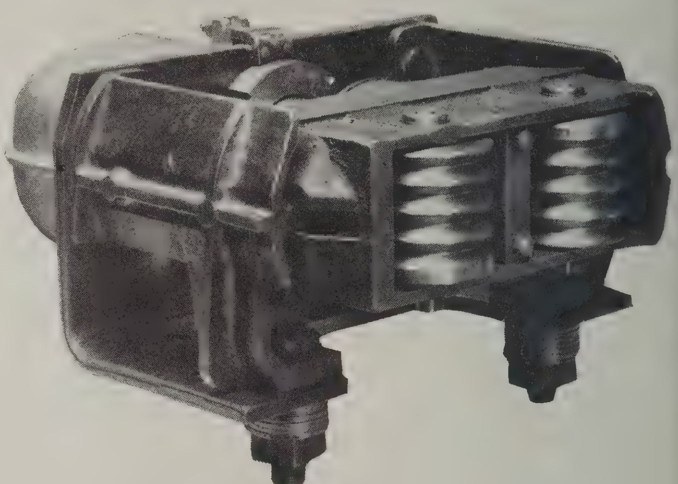
The Speed Control Mechanism

The speed control mechanism is of the centrifugal type and is bolted on the end of the journal outside of a pony



Side View of Shoe Mechanism

truck wheel. The speed control is operative as required to cause a service application of the brakes should a predetermined safe speed be exceeded in traveling through a caution block or in restricted speed territory, around curves, or through crossovers, or the approach thereto. The speed control has a manual control feature in connection with it requiring the engineman to operate a switch manually to permit the train to pass a caution or a stop signal without a brake application, provided he is traveling within the predetermined safe speed limit allowable for passing caution and stop signals. A graduated service application of the brakes through the medium of the speed control is arranged in such a manner that a full service application takes place for a high speed and a more moderate application is provided for in connection with trains traveling at lower speeds. For freight service, a limited high speed adjustment of, say, 40 to 45 miles an hour can be made on the speed controller if desired,



Shoe Showing Construction and Location of Contact Rollers

in order to provide for proper operation of tonnage trains on gravity grades and under other conditions.

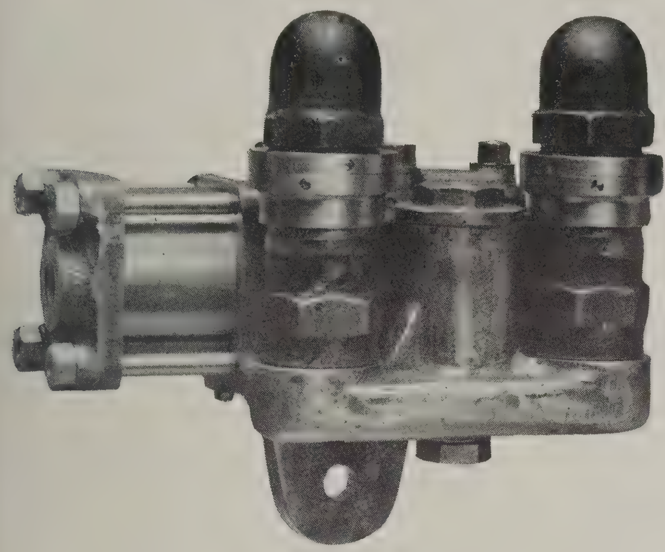
The speed controller is of heavy malleable iron construction, the controlling arms being located on the back plates, allowing no overhang and arranged at right angles to the axles of the pony truck. All moving parts in the controller are lubricated by a small quantity of zero signal oil contained in the casing. The speed control circuit is so arranged that in case of an accident a service application of the brakes will follow. Should this occur the engineman can break a seal on a special condulet provided on the front end of the engine, open it and insert fuse plugs, thus cutting out the speed controller. This will allow him to proceed and still be protected by the automatic stop.

The Contact Shoe

The contact shoe is located on a bracket carried on the front or rear truck of the tender on the engineman's side. It consists of a malleable casting supporting two large steel rollers, so arranged that three contact points ride on the ramp rail to insure proper electrical contact regardless of frost or other foreign matter on the ramp rail. The rear roller is placed slightly lower in the housing than the front roller. This allows it to make contact first with the ramp before the front roller makes contact. The stem supporting the roller housing is equipped with heavy buffer springs, both front and back, to equalize the shock around the stem.

The upper part of the stem is supported by a heavy bearing with a bolt passing through the bearing and the slotted stem. The stem is made of steel tubing with a ⅜ in. wall and is supplied with a spring buffer to act as a cushion for the tube. The upper part of the stem in its vertical movement over a ramp operates two circuit breakers located in the housing. There are two safety

rods supporting the shoe so arranged that the breaking of both rods will allow the shoe to drop about ¾ of an inch. This causes a service application of the brakes on the train. The rods are supported on 1 in. rubber



The Automatic Brake Valve

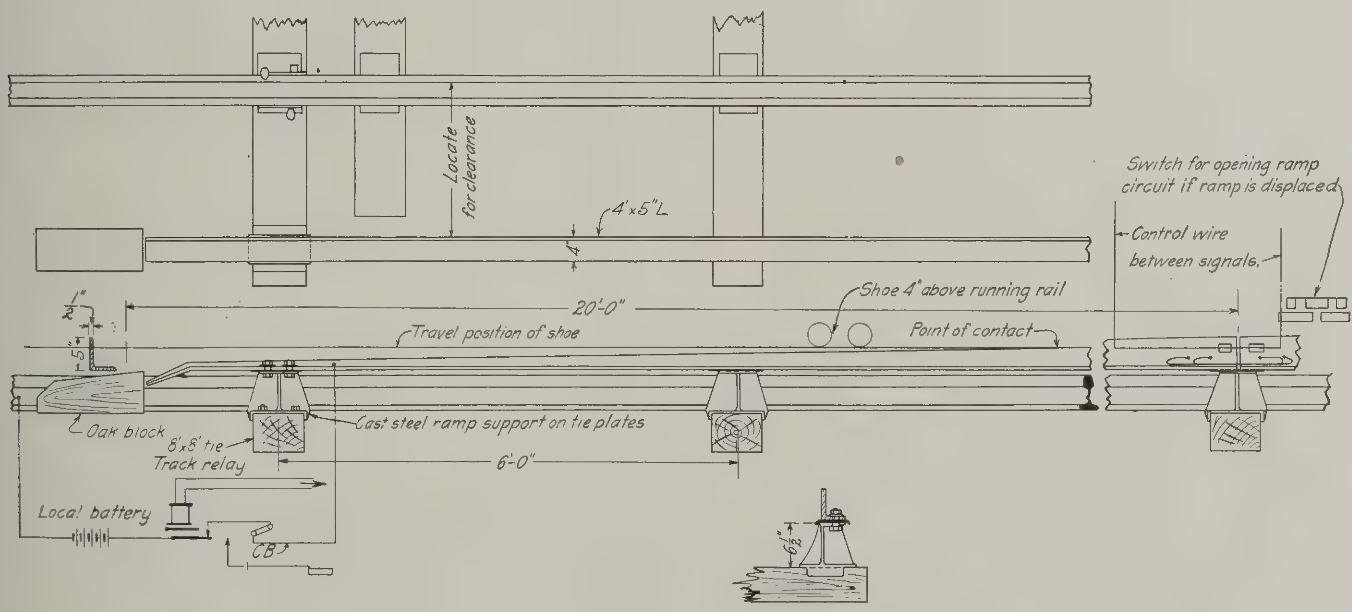
buffers at the top, no air connections are made to the shoe mechanism and the shoe and stem are of sufficient weight to insure the return of the shoe to the normal downward position after passing over a ramp. The shoe

The Ramp

An 80 ft. ramp located at the proper distance from the gage of the rail to ensure right clearances and placed parallel to the track is fastened on ties. The ramp is connected electrically to the track relay and the signal control circuit so that the removal of the ramp or breakage in the ramp circuit will cause the roadside signal to indicate stop and also will give a "stop" indication on the ramp one block in advance. The location of the ramp will be governed by traffic and train braking conditions.

The ramp is made from 4-in. by 5-in. L's and is in four parts. There are two 20-ft. leads and two 20-ft. intermediate sections. The top of the ramp is planed and the two end pieces are on a taper of 3/16 in. in 12 in. The ramp is held in place by cast steel ramp supports located every 6 ft. which are bolted to 8-in. by 8-in. sawed ties of the proper length to provide the right clearance for the ramp. Standard interlocking tie plates are used to tie the ramp in solidly to the track and to hold it in proper gage relation to the rail. The ramp is insulated from its supports by fiber insulation. Each end of the ramp is turned down and protected by a tapered oak block to prevent dragging equipment from causing damage.

The engine circuits operate on the closed circuit principle and contain a specially constructed heavy electrically operated circuit controller for both clear and unclear circuits. The opening of any closed circuit will result in a service application of the brakes. The elec-



Two Views of the Construction of the Ramp, With the Circuit for the Ramp Feed

is contained and supported in a built-up housing of a boiler plate angle on cast steel and guides.

Visual signals located in the engine cab consist of a green light indicating "clear" and a yellow light indicating "caution." When a combination of a green and a yellow light exists this indicates a "permissive proceed" signal. If engines are double heading and one engine is cut out the signal lights, however, will indicate in the cabs of all engines. An audible signal, such as the Klaxon, can also be used.

trical controller and a 10-volt storage battery are suspended in a box under the engine tank.

Many a strong program has suffered on account of weak support.

Friendship is the most essential thing in the business world.

The man who gets the most gives everything that he has.

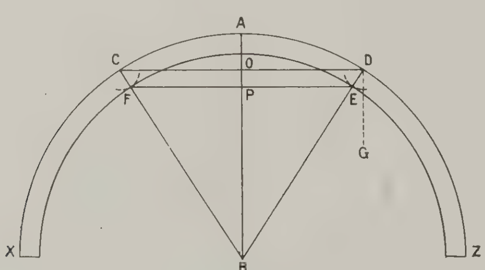
Laying-Out Mica V-Rings for Commutators

By Earl H. Hall

Electrician, Chicago, Rock Island & Pacific, Silvis, Ill.

Ordinarily the segments of a commutator are held in place by means of an expanding wedge shape extension, one end of which fits under a lip on the spider and the other end goes under a ring that holds the commutator together. The segments of the commutator must be insulated not only from each other, but also from the spider and ring that fits this holding extension.

In repairing car lighting generators, headlight generators of various kinds of d.c. motors an electrician is often required to overhaul a commutator and one of the most difficult parts of such a job is to get the mica insulation to fit over the V-shaped spider and ring that grip the holding extension of the commutator bars. A method that was worked out on the Rock Island and which is being used successfully for laying out and cutting mica for these V-rings is as follows:



Method for Laying Out Mica V-Rings for Commutators

In reality the surface of this V-ring is just like the outside of a slice cut out of a cone. Therefore it is readily seen that in order to cut a piece of sheet mica to fit flat all around that it must be cut as the arc of a circle but of somewhat greater diameter than the actual diameter of the ring.

Upon a sheet of mica draw a line of indefinite length as AB near the middle. A line as CD is drawn perpendicular to AB and of a length such that OC is equal to the radius and of the large inside V-ring, thus CD equals the diameter. With a radius as CF or DE, equal to the width of the mica on the V-ring, small arcs are drawn. Then line FE representing the inside diameter of the inside V-ring is drawn perpendicular to AB, being bisected at P and so placed as to make CF and ED equal to the width of the ring.

The line DG is drawn perpendicular to CD. The angle EDG is determined by means of a combination protractor set. Opposite the degree number on the table will be found the cosecant (the multiplying power) with which to multiply the line OD. The product will be the length of the line as BD. Using BD as a radius an arc as $XCADZ$ is drawn of a length equal to the circumference of the large diameter of the V-ring.

For cutting the inside mica, 3/16 in. must be added to the distance BD on account of outside mica ring, the outside radius of which is equal to that of the small ring or arc at CD. To lay off the circle FE, the distance between D and E and the added 3/16 in. must be subtracted. The outside ring of mica can be cut on the same principle.

Table of Cosecants

1°=57.30	31°=1.9416	61°=1.14335
2°=28.65	32°=1.8871	62°=1.13257
3°=19.11	33°=1.8361	63°=1.12233
4°=14.34	34°=1.7883	64°=1.1126
5°=11.47	35°=1.7434	65°=1.1126
6°= 9.567	36°=1.7013	66°=1.09464
7°= 8.206	37°=1.6616	67°=1.08636
8°= 7.185	38°=1.6243	68°=1.07853
9°= 6.392	39°=1.5890	69°=1.07115
10°= 5.759	40°=1.5557	70°=1.06418
11°= 5.241	41°=1.5243	71°=1.05762
12°= 4.810	42°=1.4945	72°=1.05146
13°= 4.445	43°=1.4663	73°=1.04569
14°= 4.135	44°=1.4396	74°=1.04030
15°= 3.864	45°=1.41421	75°=1.03528
16°= 3.628	46°=1.39016	76°=1.03061
17°= 3.420	47°=1.36733	77°=1.02630
18°= 3.236	48°=1.34563	78°=1.02234
19°= 3.072	49°=1.32501	79°=1.01872
20°= 2.9238	50°=1.30541	80°=1.01543
21°= 2.7904	51°=1.28676	81°=1.01247
22°= 2.6695	52°=1.26902	82°=1.00983
23°= 2.5593	53°=1.25214	83°=1.00751
24°= 2.4586	54°=1.23607	84°=1.00551
25°= 2.3662	55°=1.22077	85°=1.00382
26°= 2.2812	56°=1.20622	86°=1.00244
27°= 2.2027	57°=1.19236	87°=1.00137
28°= 2.1301	58°=1.17918	88°=1.00051
29°= 2.0627	59°=1.16663	89°=1.00015
30°= 2.0000	60°=1.15470	90°=1.00000

The Last Long Hill

Oh, they handed me a shovel
And put me on a "Mike";
Put her ahead of ninety cars
To wheel 'em o'er the pike.

My face was all shaved up,
The barber'd trimmed my curls,
With a brand new suit of overalls,
I was fixed to wave at all the girls.

The fire-box sure looked big to me,
But then I didn't know
Just how much coal that it would take
To make this old girl go.

And when the hogger pulled 'er out,
Although his face look kind,
Before we'd gotten twenty miles
I was almost ten behind.

Says he to me, "Young man,
You've got to get it in 'er";
I was sweatin' and a swearin',
Every minute gettin' thinner.

All day we dragged that train,
As on our way we wended;
And believe me I was tickled
When that old trip was ended.

The hogger turned his face to mine
After we'd got in,
Says he to me, "Young man,
I think you're gettin' thin."

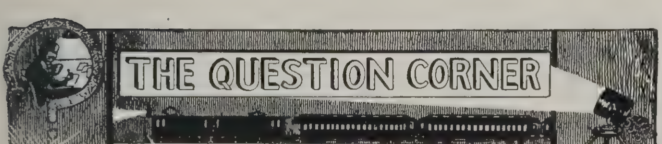
"I can't see your face for dirt,
But really you look sick,
And I have me doubts, young man,
Whether you will stick."

"No," says I, "I am not sick,
Just feel a little blue,
And if you were on your first trip,
No doubt so would you.

"But it wasn't the drag
That nearly broke my will,
Nor the twelve long hours on duty,
But that last long hill."

I've spaded diamonds now
For over fourteen years;
And ever since that day
I've always had my fears.

I've a sinking feeling in my heart,
I almost have a chill
When on the road I have to face
That last long hill.

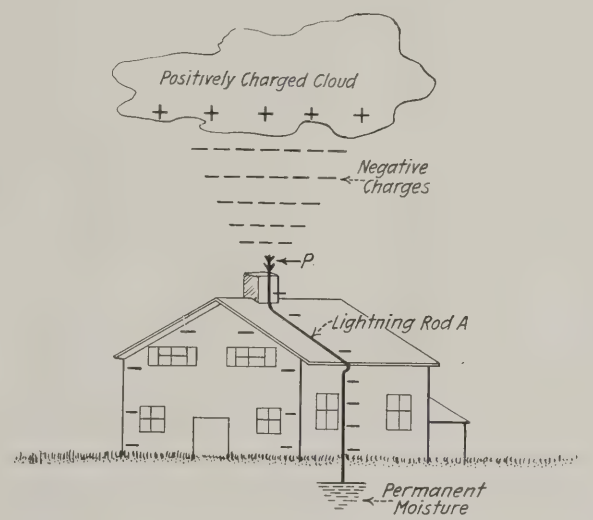


Answers to Questions

1. *I have often heard it said that a grounded aerial acts as a protector to buildings rather than a hazard during lightning storms. Will you please explain the reason for this?*

Why Grounded Aerials Protect

To explain the reason why a grounded aerial is a protection and not a menace to property requires a little preliminary discussion of the nature of lightning discharges. It will not be necessary to go all the way back to the elementary principles to investigate the electrical phenomena involved in a stroke of lightning. It is really nothing more than the discharge of a huge condenser of which the earth and the clouds are the plates and the air the dielectric. It is sufficient to say that under certain conditions clouds become highly electrified; that is, they become heavily charged with positive or negative charges of static electricity. Under proper atmospheric conditions, the static charge eventually becomes so great that the stress between one cloud and another or between the cloud and the earth reaches a point where the air breaks down and the lightning flash or discharge takes place. If there was any way in which the charged cloud could be kept from reaching this stress peak, it is obvious that the direct stroke might be prevented. It has been found that a grounded metallic rod, the upper end of which projects from the top of a building, will often reduce the stress between a charged cloud and the earth to such an extent that a direct stroke does not take place. The reason for this is shown in the illustration. In accordance with the laws of static charges, unlike charges of electricity, attract each other and if we assume that the cloud is positively charged, the earth in its vicinity will be negatively charged. The negative charge will be drawn upward from the earth through the rod and a silent discharge takes place into the atmosphere which reduces the stress by neutralizing the charge on the cloud. In this way a direct stroke of lightning is frequently prevented. The aerial used for radio reception or transmission, when grounded, acts in a similar manner although not to the same extent that the pointed lightning rod does. However, if a heavily charged cloud approaches rapidly and there is little time for this neutralizing action to take place, a direct stroke may occur and points which project highest above the earth's surface are most likely to be struck.

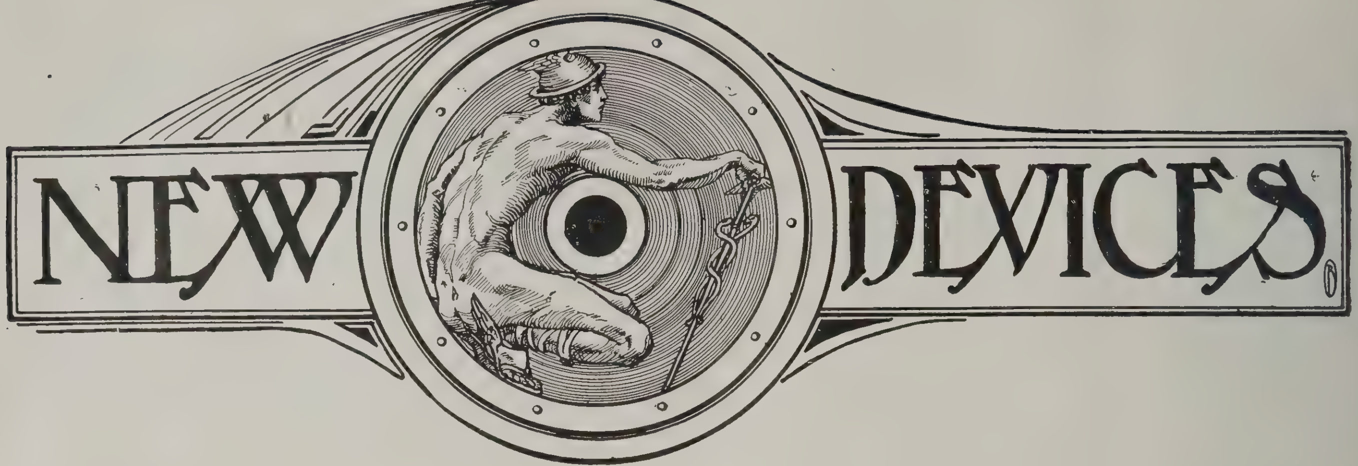


Action of Lightning Rod in Neutralizing Static Charge on Cloud

Questions for June

1. *What are the principal causes for excessive growth of battery plates?*—M. M.

2. *I should like to have someone give a good method for testing polarity of poles on a car lighting generator after coils have been changed.*—C. J. D.



Floodlight Projector

A type of floodlight projector, known as the Pyle-O-Lyte, is being manufactured by the Pyle-National Company, Chicago, Ill. The projector is made in several sizes and designs. The bodies of the projectors are of cast aluminum alloy and all steel parts are sherardized.

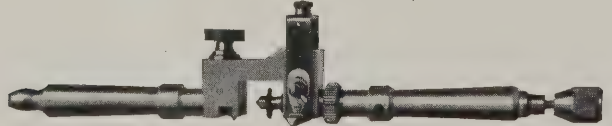
Glass reflectors are used of of the non-glare type, which are made of tinted optical glass. Provision is made for ample protection against peeling or discoloration of the silvered surface.

The projectors are equipped with sectional, clear wire-glass for ordinary work at normal range, but for work at close range, requiring uniform distribution, wide angle dispersion lenses are supplied. Simple means are provided for focusing the lamp and adjusting the body of the projector. Sufficient ventilation is provided so that lamps up to 1,000 watts may be used in the 12-in. and larger units.

Pyle-O-Lite, 12-Inch Floodlight Projector Type 20-F-6060

Commutator Slotting Machine

A commutator slotting machine in which a number of noteworthy features have been incorporated has been developed by the Martindale Electric Company, Cleveland, Ohio. The machine is known as the Imperial Undercutter and the cutters which are used are V-shaped milling cutters. The advantages claimed for the V-shaped slot are that it is self-cleaning and that when it is cut no strips of mica are left along the edges of the bars to be scraped by hand from the edges of the slots after the slotting machine has been used.



The Imperial Undercutter

The machine is equipped with a movable block and guide for riding in an adjacent slot and a micrometer screw adjustment is provided to get the saw in the exact center of the mica. The depth of the slot can be regulated accurately by an adjustable V-shaped rest. The handle on the left is hollow to permit the attachment of a compressed air line to blow away the dust from the front of the cutter and enable the operator to see his work clearly at all times. The machine is driven through a 4-ft. flexible shaft from an electric drill and is furnished either with or without the motor.

Full Automatic Attachment for Westinghouse Type CS Control Switches

A full automatic attachment that can be added to any type CS circuit-breaker control switch to make the circuit breaker controlled from it electrically full automatic has been placed on the market by the Westinghouse Electric & Manufacturing Company. With this attachment added, the breaker cannot be held in the closed position on overload or short circuit when arranged to trip from current transformer only or from current transformer actuating circuit closing relays.

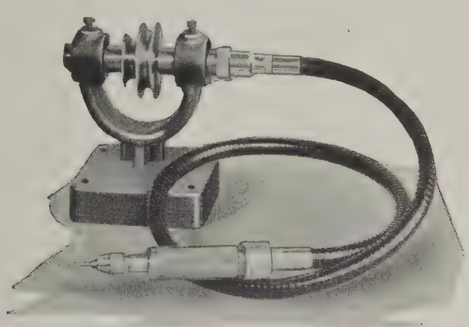
Full Automatic Attachment for Type CS Control Switch

To apply the attachment to existing installations of type CS control switches it is only necessary to shorten the switch shaft and drill a hole for the engaging pin. The attachment consists of a coil, a magnetic circuit, a moving core, and a trigger normally engaging the switch shaft, so arranged that when the coil is energized, either from a direct current source through relays or from excessive current when connected to current transformers, the core is moved in the direction necessary to release the trigger. This allows the switch shaft to return to the neutral position free of the handle.

When a circuit breaker is closed on an overload or a short-circuit, the trip-free attachment immediately operates and allows the control switch to return to the neutral or off position simultaneously with the tripping of the breaker. Before the circuit breaker can be again closed, it is necessary to turn the switch handle to the off position to engage the switch shaft.

Mica Under-Cutting Device

The Peerless under-cutter, recently developed by Joseph Weidenhoff, Chicago, can be so quickly applied to the operation of under-cutting mica insulation on commutators that it is possible, in some cases, to under-cut commutators in less time than is required to mount a larger type of under-cutting device. As may be seen from the photograph, the under-cutting resembles a dentist's drill—in fact, the under-cutting of the mica is accomplished by the use of a standard dental cutting burr. With the hand piece held in the palm of the hand, it is guided by the fingers and thumb with little effort to follow the slot in



Mica Under Cutting Tool

the commutator. Spiral and straight slots may be cut with simplicity and speed.

The flexible shaft with its flexible metal casing, which acts as a guide and protection for the shaft, are of high grade construction such as will give sufficient driving power with resistance to tortional strain. The shaft and casing have unusual flexibility that will permit of bending in one or more curves as may be required.

The driven end of the flexible shaft is connected to the shaft which rotates in the bearings of the bench stand. On the other end of the flexible shaft is the hand piece by which the cutting burr is guided. A feature of this hand piece is its small outside diameter which permits of under-cutting close up to the shoulder of the center slots of commutators up to 4-in. in diameter.

Power is given to the pulley on the shaft of the bench stand by a round belt driven from any convenient source of power, be it line shaft, individual motor of 1/16 hp. or more, or from a pulley held in the chuck of a lathe, or drill press. The speed of the bench stand shaft should be from 3,000 to 4,000 r. p. m.

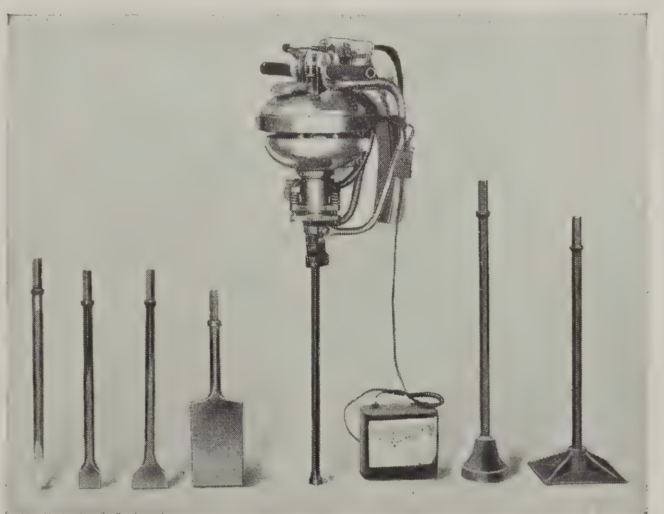
An Improved Thermometer

A new thermometer which has the advantage of being easily read has been developed by the C. J. Tagliabue Manufacturing Company of Brooklyn, N. Y. The device is a regular mercury thermometer but employs a new principle upon the indicating scale. Immediately behind the column of mercury is a long red mark. As the mercury rises or falls this read line appears longer or shorter, as the case may be. The top of the mercury column is instantly located, since the same point is indicated by the bottom of the red line the bright color of which stands out prominently.

A Gasoline Hammer Drill

A gasoline impact drill of the air hammer type is now being manufactured by the Pennsylvania Gasoline Drill Company of Philadelphia, Pa. The mechanical principle of this gasoline hammer drill combines the action of the air hammer and the gasoline engine in such a manner that the drilling unit has but two moving parts, the hammer piston and the flywheel assembly. No crank shaft or connecting rod is employed and there is no spring or other holding member used in the internal construction. No inlet or exhaust valves or cam shafts are used as the air and exhaust passages are fixed ports cut through the solid steel of the cylinder. The down or power strokes of the hammer piston are made with approximately 900 lb. of the gasoline explosive force, thrusting it forward to hit the drill with terrific force. The flywheel is employed to return the hammer piston on the upward or compression stroke. Approximately 1,800 impacts are struck each minute. For carburetion, a gasoline mixing valve is used which permits the drill to be worked at any angle.

While the drill continues to run at full speed, the



The Gasoline Hammer Drill With Some of the Tools That May Be Used

operator shifts it from one position to another without affecting the operation. To start the drill, the operator has but to give the rim of the flywheel a pull by hand. A four or six dry cell battery is used in ignition. The drill has a great variety of uses and can be equipped with many different types of tools for various kinds of work. One job on which it is found useful is that of excavating for pole lines in rocky and inaccessible places. It can also be used for driving spikes, ramming the ballast or tamping ground about newly set poles. The drill weighs approximately 70 lb. and is intended to be used by one man. A little over one-half a gallon of gasoline will operate the drill for a day.

General News Section

Gibbs & Hill, consulting Engineers, New York City, have been retained by the Virginian Railway in connection with the electrification project of that road.

The Howell Electric Motors Company has opened a New York office located at 17 East 42nd street, with R. W. Baker in charge as New York district manager.

The Gibb Instrument Company, of Bay City, Michigan, manufacturers of electric welding equipment, have been appointed distributors of the General Electric Company's arc welding electrodes in the middle west.

The American Institute of Electrical Engineers will hold its 39th annual convention at Swampscott, Mass. in the New Ocean House, June 25 to 29, inclusive. The morning sessions will be devoted to technical discussions and the afternoons and evenings to inspection trips and entertainment.

The Black & Decker Manufacturing Co., Baltimore, Md., announces a substantial reduction in price on the several types of portable drill and grinder equipment which it manufactures. The change in price was effective on June 1. It represents the second reduction which this company has made this year.

The United States Electrical Tool Company, Cincinnati, Ohio, has recently opened a new district office at 430 North High street, Columbus, Ohio, with E. M. Beeler as manager, also opened a new district office at 412 First street, National-Soo Line building, Minneapolis, Minn., with Thomas H. Caley as manager.

The General Electric Company, Schenectady, N. Y., announces the appointment of H. R. Sargent to the position of managing engineer of the wiring supplies division under the development plan which will create several unit divisions at the Bridgeport, Conn., factory. Mr. Sargent was formerly manager of the wiring supplies division at the Bridgeport works.

The Johns-Pratt Company, of Hartford, Conn., manufacturers of Noark fuses, meter service and protective devices, cut-out bases, fuse accessories, Vulcabeston packing and insulating parts, and Johns-Pratt molded insulation, have established an export division with office at 30 Church street, New York City. Messrs. E. Wilhelm Droosten and W. L. Urquhart, who have had extensive experience in handling export business of electrical manufactures, will be in charge of this division.

The Westinghouse Electric & Manufacturing Company on May 26 formally opened its new renewed parts plant on Lang avenue, Homewood, Pittsburgh, Pa. E. C. Brandt is manager of the new plant. Mr. Brandt has been a Westinghouse employee for 18 years. W. C. Henderson, formerly general foreman of the railway department at the East Pittsburgh main works of the Westinghouse Company, is superintendent. F. F. Rohrer will direct the sales activity and A. L. Broomall will be renewal parts engineer.

The New York, New Haven & Hartford, on May 21, suffered the longest tie-up since the installation of electric power, 17 years ago. A short circuit occurred in one of the circuit breakers on the switchboard at the Cos Cob power station, with the ultimate result that two generators were very badly damaged and put out of commission. The delay to train movement was about 90 minutes.

The East approach of the Atchison, Topeka & Santa Fe bridge across the Mississippi river at Ft. Madison, Iowa, was damaged by fire on May 24, and traffic was blocked until the 28th. This structure was used jointly for railway and highway traffic and the fire, which is thought to have started on the wagon bridge, destroyed 400 feet of the railway structure and approximately 2,500 feet of the highway approach. Trains were detoured over the Chicago, Burlington & Quincy from Ft. Madison, Iowa, to Galesburg, Ill., during the reconstruction which was completed on May 28.

The Pennsylvania Railroad has appropriated $500,000 for the construction of a masonry dam in Tipton Valley, about ten miles east of Altoona, to supply the shops and railroad yards with an adequate quantity of water. Over nine million gallons of water are consumed every working day by these shops; almost double the quantity used by the entire city of Altoona, with its population of 70,000. The new dam will be about 400 ft. long, 78 ft. high, and 60 ft. thick at the base. It will involve 18,000 cu. yd. of excavation and will make a lake 32 acres in extent, with a capacity of 250 million gallons. Tipton Run is a pure mountain stream very desirable for locomotive uses.

New York Electrification Bill Becomes a Law

All railway lines within the city limits of New York City must be electrified before January 1, 1926, according to a recent act of the legislature which was signed by the Governor on June 2, in spite of the protests of the railways affected. These are the New York Central, the New York, New Haven & Hartford, the New York Connecting, the Long Island, the Staten Island Rapid Transit and the Baltimore & Ohio—in addition to the New York piers of several other roads.

Erie Installing New Power Equipment at Susquehanna

The need for greater boiler capacity for the Erie shops at Susquehanna, Pa., has resulted in the installation of a new motor driven air compressor. Purchased electric power will replace the need for added boiler capacity. At present a steam driven compressor with a capacity of 2,650 ft. per min. is supplying the requirements of the shop. This will be replaced by a synchronous motor driven compressor with a capacity of 3,600 cu. ft. The

steam unit will be sent to Hornell, N. Y., and a smaller steam driven unit now in service at Hornell will be installed at Susquehanna as an emergency unit.

A 13-panel switchboard is also being installed and underground cables laid between the switchboard and the power lines which bring power to the shops. The switchboard provides for the control of the motor driven compressor, two motor generator sets, one of which is to be installed, and the various distribution feeders for shop power, light and electric welders. Growing shop requirements have made improved power facilities necessary and 220-volt alternating current, 220-volt direct current and 110-volt direct current is furnished to the shop. The work should be completed by the latter part of July.

Japanese Company to Resume Construction

It is reported that the Japanese Government has decided to provide the Taiwan Electric Power Company with funds to enable it to continue construction of the generating plant on which work has been temporarily suspended. The original plans were for the construction of a power plant of 100,000 kilowatts capacity to cost $20,000,000. These have been modified to some degree, it being now estimated that the total amount of capital required will be $15,000,000.

Railway Order from Japan

The Musashino Railway of Japan has placed an order with the Westinghouse Electric & Manufacturing Company for three electric locomotives, two motor car equipments and two trailer car equipments.

Each locomotive will be equipped with four 100 horsepower motors geared direct to the driving axles and will weigh 33 tons. The locomotives will be controlled by standard electro-pneumatic control, and will operate over a 1,200-volt system. The mechanical parts for the locomotives will be furnished by the Baldwin Locomotive Works.

The motor car equipments will exactly duplicate those now operating on this road, which consist of four 65 horsepower motors each with electro-pneumatic control for double-end operation. The new equipments will be so designed that multiple unit operation with the old equipments will be possible. The trail cars will not be equipped with motors but will have control apparatus arranged for double-end operation with the motor cars.

The Musashino Railway will operate these new equipments from Ikebukuro, situated about ten miles northwest of Tokio, west to Han-no, a distance of twenty-seven and one-half miles. This road is a narrow gage (42 inches) system operating on 1,200-volt direct current drawn from an overhead trolley wire.

Niagara Junction Buys Two New Locomotives

The Niagara Junction Railroad which conducts a switching-spotting service exclusively in the vicinity of Niagara Falls, has recently purchased from the Westinghouse Electric and Manufacturing Company, two electric locomotives, increasing their total number now in service to five. Each of the new locomotives will weigh 43 tons equipped with four Westinghouse type 552-FA-17 motors each rated at 65 horsepower, and HLF control. It will be possible to operate these two locomotives as a multiple unit to obtain sufficient tractive effort when hauling trains over the "hump." The railroad officials originally intended to purchase one locomotive weighing approximately 81 tons but later decided that with two locomotives whose combined weight power would afford the same result, a more flexible service could be rendered. This railroad operates on 600-volts direct current, drawing its power from an overhead trolley wire by a wheel and pole or pantograph.

Wage Statistics for March

The number of employees reported by Class I steam roads for March, 1923, was 1,816,479, an increase of 246,321, or 15.7 per cent, over the number reported for the same month last year, and an increase of 32,924, or 1.8 per cent, over the number for February, 1923, according to the monthly summary of wage statistics published by the Interstate Commerce Commission. The total compensation in March, 1923, was 17.9 per cent greater than in March, 1922. In this period the earnings per hour for straight time for the employees reported on an hourly basis decreased from 58 cents to 56 cents an hour. The overtime earnings decreased from 82 cents to 81 cents an hour. Taking the straight time, overtime, and other compensation together, these employees reported on an hourly basis, were paid an average of 61.8 cents per hour in March, 1922, and 59.9 cents in March, 1923. But, owing principally to an increase in the amount of overtime worked, they averaged 227 hours per employee in March, 1923, as against 215 in March, 1922, with the net result that their average compensation per month increased from $133 to $136 in the same period.

NUMBER OF EMPLOYEES AND COMPENSATION BY MONTHS

Month	Number of employees	Total compensation
March, 1922*	1,570,158	$216,704,408
April, 1922	1,578,133	203,413,071
May, 1922	1,628,228	216,672,028
June, 1922	1,685,414	222,932,689
July, 1922	1,467,824	193,571,244
August, 1922	1,594,074	224,976,644
September, 1922	1,708,591	238,735,394
October, 1922	1,804,315	255,514,000
November, 1922	1,820,463	249,286,713
December, 1922	1,788,590	247,672,515
January, 1923	1,779,516	250,051,786
February, 1923	1,783,555	230,416,541
March, 1923	1,816,479	255,447,764

*Excludes Detroit, Toledo & Ironton

Electrification of Buenos Aires Western

Electric operation in the Buenos Aires suburban zone of the Buenos Aires Western Railway was inaugurated on April 30. Electrification was adopted in order to give the railway's suburban trains access to the Subterraneo (subway) station at Plaza Once (near the Buenos Aires Western's Once Terminal) thereby facilitating the transfer of its passengers with the subway.

In all, 70 track miles have been electrified in addition to 3 miles of a freight tunnel leading from the Once Terminal to the Port of Buenos Aires. Power is produced in the generating station in the form of three-phase current, 20,000 volts, 25 cycles. At substations it is converted to direct current of 800 volts and transmitted through a third rail. Freight tracks will be equipped with overhead contact wires.

Personals

George L. Bebout, who has been for some time engaged in special electrical work on the steamer "Leviathan," has returned to the C. & O. where he will take up the duties of foreman electrician at Stevens, Ky.

C. W. Nelson, formerly electrician of the C. & O. at the 17th street shops, Richmond, Va., has been appointed to the new position of supervisor of train control equipments with headquarters at Richmond. Mr. Nelson will report to G. W. Bebout, electrical and signal engineer.

Dr. Edward P. Hyde, who organized the Nela Research Laboratories in 1908, and who for the past few years has occupied the position of Director of Research of the National Lamp Works of the General Electric Company has tendered his resignation to take effect June 30 of this year. Dr. Hyde, who has been active in scientific and technical affairs for a number of years, has decided to take a prolonged rest abroad. He will temporarily discontinue many of his activities in the scientific and engineering societies, but will retain his office of president of the International Commission on Illumination until its plenary meeting which is scheduled to be held in this country in 1924.

Allen B. Coffman has resigned as sales engineer for Crouse-Hinds Co., to become manager of the Philadelphia District for the Reliance Electric & Engineering Co., Cleveland, Ohio, manufacturers of electric motors. For the past three years, while connected with Crouse-Hinds Co., Mr. Coffman made a study of different types of electrical installations in various industries from Pennsylvania to Florida.

Previous to his association with Crouse-Hinds Co., he was assistant electrical engineer for the Philadelphia & Reading Railroad for approximately four years, having gone with that road from the Pennsylvania Railroad electrical department.

After graduating in the course of electrical engineering from the Pennsylvania State College, he worked for some time in the factories of both Crocker-Wheeler Co. and Wagner Electric & Mfg. Co.

Mr. Coffman will continue to make his headquarters in Philadelphia with office in the Perry Building, 16th and Chestnut streets.

Harris J. Ryan, professor of electrical engineering at Stanford University, California, was elected president of the American Institute of Electrical Engineers at the annual business meeting held in the Engineering Societies Building, New York City, on May 18. Mr. Ryan was born at Powell Valley, Pa., on January 8, 1866. He was educated at Baltimore City College and Lebanon Valley College at Annville, Pa. and at Cornell University from which place he graduated with the degree of M. E. in 1887. For a time following his graduation he was instructor of physics at Cornell. Later he became professor of electrical engineering at the same place. In 1905 he took up the duties of professor of electrical engineering at the Leland Stanford University, which position he still holds. Professor Ryan has acted as consulting engineer for the Los Angeles Aqueduct Power Bureau. He was a member of the jury of the awards, department of electricity, at the Chicago Exposition in 1893. In 1904 he was a delegate to the International Electric Congress at the St. Louis Exposition and at the Pan-American Exposition in 1915, he was also a member of the jury. Besides being a member of the Institute of Electrical Engineers, Professor Ryan is a member of the Electro-Chemical Society, Institute of Radio Engineers, Society for the Promotion of Engineering Education, American Physics Society and a number of others.

Harry D. Rohman, formerly vice-president and chief engineer of the Stone-Franklin Company, New York, has become associated with Robert C. Shaal in the R. C. S. Equipment Corporation, a company dealing in general railroad supplies with offices at 8 East Forty-first street, New York City. Mr. Rohman is a graduate mechanical and electrical engineer with extensive railroad experience, having been prominently identified with the car lighting field and for several years was in close touch with railroad matters abroad. After graduating from the technical schools of Zurich, Switzerland, he entered the works of the Oerlikon Electrical Construction Company, and in 1903 qualified as an electrical engineer, with experience in high and low tension and a.c. and d.c. work, especially electric traction. Later he entered the service of J. Stone & Co., London, and in 1910 was appointed chief of the testing and experimental departments. In 1914 he was appointed chief assistant electrical engineer, and held that position until October 1, 1915, when he entered the service of the Franklin Railway Supply Company as chief electrical engineer. In 1919 he was appointed chief engineer of the Stone-Franklin Company and later vice-president of the same company.


H. D. Rohman

Trade Publications

Coaling and Cinder Plants.—A bulletin has been issued by the Roberts & Schaefer Company describing a one-man operated plant which this company has recently developed to perform the dual functions of coaling locomotives and handling cinders. The bulletin is illustrated with line drawings and photographs showing the plant in elevation and plan, as well as sectional views illustrating its general appearance and operation.

The Allan Manufacturing & Welding Company, Buffalo, N. Y., is distributing two illustrated folders. One of these describes the Cyl-Grind grinder which is a portable adjustable grinder for the removal of excessive metal or high spots from cylindrical surfaces. The second folder describes the application of the Allan polyphase, alternating current, arc welders which are constructed for any primary voltage and cycle.

Railway Electrical Engineer

Volume 14 JULY, 1923 No. 7

Experience in Designing Catenaries

Experience has probably been the most important factor in the development of overhead catenaries which would meet all the requirements for delivering power current to the pantagraph of a car or locomotive. Heavy current requirements, high speeds, or a combination of the two, complicate the design. Some of the early designers thought the catenary structure should be as rigid as it could be built. They discovered, however, that irregularities in the height of the wire often resulted in the wrecking of either the pantagraph or the catenary. Now catenaries are built in a variety of forms but always with as great amount of flexibility as is consistent with the need for keeping all parts in their proper position and preventing the structure from swaying.

Catenaries for 11,000-volt power were installed by the New York, New Haven & Hartford and the Erie in 1906. These were the first of their kind to be installed in this country. They were installed simultaneously and developed separately. Elsewhere in this issue is an article dealing with the experience which the Erie has had in developing a satisfactory catenary. This includes the use of a catenary consisting of a single messenger and contact wire, and another consisting of a man and auxiliary messenger and contact wire; the use of copper, steel and now Phono-Electric contact wire and the development of suitable fittings. It is experience which may be of profit not only to those ho are considering the building of a catenary, but also to those who have such a structure to maintain.

32-Volt Portable Extensions

In perhaps a dozen places on two or three railroads, 32-volt circuits are used for portable extension lights in shops and enginehouses. The practice is quite new, but there is a good possibility that it will gain in popularity. It has been claimed that men have been killed by accidentally coming in contact with a live part of a 110-volt portable extension. In few, if any one, of these cases has anyone been able to prove conclusively that the man was actually killed by electric shock, for in practically every instance it could be as well shown that the man was killed by a fall. It is quite possible, however, that the electric shock was contributory and caused the man to fall or effected an added shock to his nervous system.

Under average conditions a 110-volt circuit can be handled without any risk and it is thus properly considered a voltage that is not dangerous. When it is used on a well grounded and perhaps wet place, however, such as on or inside a locomotive, conditions are different. It is probably then not dangerous to a person in normal healthy condition, but when the workman comes in contact with it, as he does infrequently, he gets an uncomfortable shock that makes him squeamish about using the lamp. The result is that he does not do his work as he should. If he is inclined to "soldier," he uses this excuse to do less work. For these reasons a few 32-volt portable extension circuits have been installed. The circuits are not grounded and the voltage is so low that a workman will not get a shock he can feel—even though he tries—and he soon learns to have confidence in his light.

The principal objection to the use of 32-volt portable lights is that there are no especially rugged types of 32-volt lamps available. Any 32-volt lamp of a given type will, of course, withstand more mechanical abuse than a 110-volt lamp of the same type, but there are no 32-volt lamps available which compare in ruggedness with the 110-volt mill type or the 110-volt carbon lamps. Neither the manufacturers nor the users, of course, want to add variety to the number of different types and sizes of lamps they manufacture or use. Perhaps someone well versed in the use or design of lamps can supply the best method of procedure to those who want to use 32-volt portable extensions.

The Maintenance of Electric Rolling Stock

A very interesting report on the problem of maintenance of electric rolling stock was presented at the recent meeting of the Mechanical Division of the American Railway Association in Chicago. The committee gave rules and regulations covering methods and periods of inspection and maintenance of both electric locomotives and multiple-unit cars. The time has not yet arrived, however, if indeed it ever does arrive, for the adoption of any given set of regulations or instructions for the care of this kind of equipment. The reason for this is not difficult to understand when one considers that the same operating conditions do not obtain on any two roads. Even if in some cases it may appear that the operating conditions are similar, it will usually be found on investigation that in some fundamental respect they are different and this difference may easily prove sufficient to be the determining factor in the maintenance program of the particular road under consideration.

The kind of electrification used is also an important element in the laying out of any maintenance schedule, for it is fairly obvious that the care required by 11,000-

volt a. c. equipment will be different in many respects from that which should be given to 3,000-volt d. c. apparatus and that both of these may be quite different from the maintenance of the rolling stock on a 750-volt d. c. system. The truth of the matter is that heavy electric traction is not standardized and since it is not, it follows almost as a corollary that maintenance methods and inspection periods cannot well be standardized either. While it may be possible to outline some general rules as to the maintenance of equipment, the advantage of so doing is questionable, for between the different systems of electrification in use and the different operating conditions determined by the traffic, grades, tunnels, or other factors, it would seem that it would be almost impossible to make any given set of regulations suitable for all of the conflicting conditions.

In the discussion which follows the report of the committee and which appears on page 206 of this issue, L. K. Sillcox of the Chicago, Milwaukee & St. Paul comments at considerable length on the wisdom of the instructions proposed by the committee. Mr. Sillcox has had much experience with the 3,000-volt d. c. operation on the C. M. & St. P. and finds that he cannot reconcile himself to the program as outlined by the committee. It is safe to say that there are other electrical men who are likewise at variance with the report and in view of the conflicting opinions, operating conditions and electrification systems, it would seem that the committee has rather a difficult task ahead of it.

Do You Deserve Promotion?

There is a sense of satisfaction which comes to every man who performs his work to the very best of his ability. The right sort of man takes a just pride in work well done; it is unfortunate that too many fail to derive the pleasure which should be theirs because of habits of carelessness and indifference. Not only can one find real pleasure in the performance of one's daily task, but the efforts put forth in accomplishing it are certain to be noticed and appreciated. How much better it is to enjoy the reputation of being a reliable, trustworthy workman in whom confidence is placed than to have the stigma of carelessness and indifference attached to your name. When an important job comes up at a critical moment, the man who has proved his ability will be the one assigned to it. He can be trusted. He is dependable. His superior knows if it is humanly possible, he will deliver the goods.

It is all too true that the number of such men is limited; and it is likewise true that they do not remain long in the rank-and-file. It is usually but a question of a short time before this type of man goes up the scale to find a higher plane and a broader scope for his abilities and energy. It is men of this stamp out of whom the foremen and officers of tomorrow will be made. There is no uncertainty about it. Look about you and you will see that your superiors are men who made good because they were not afraid to do a little hard work, and it was not really hard either for their hearts were in their tasks. The successful man in any line is bound to be the man who loves his work. If you do not like your job, by all means take up some other kind of work for you will never be successful unless you are vitally interested in your daily tasks.

If you see other men around you who seem to get ahead faster than you do, make an analysis of yourself and try to discover the real reason. Do not whine and snivel and mumble something about "pull" or "drag" and that you "never had a chance," for it is almost a certainty that you have had every chance the other fellow had and maybe more. The life of the shirker is full of grouches and complaints. There is something wrong with everybody but himself, from his viewpoint, but the truth of the matter is the fault lies wholly within himself. The theory of doing as little as possible and getting away with it is poor, poor stuff. It never gained a promotion; it never increased anyone's wages by a single cent, but it will make you miserable, discontented, unhappy and poor. If you feel that you have anything of this sort in your system get rid of it at once for you can depend upon it that it will act as a most effectual drag and forever keep you from getting the coveted position higher up.

Push-Button Control of Machine Tools

One serious difficulty encountered in the training of new shop employees during the past year was that of teaching them the proper manipulation of hand-operated controller equipment for electrically-driven machine tools. The electrical foreman in a large back shop reported that, either ignorantly or through malicious intent, the new men were constantly burning fuses or heating the transformers by improper handling of the manual controllers. He further stated that the remote push-button automatic control equipment which was in service on several machines proved to be a "life saver" while the new employees were being broken in. Other advantages of the push-button control, such as reduced running time of a machine, convenient control of start and stop, ease of adjusting the work in the machine, etc., have increased the popularity of such equipment and this road is now extending the application of push-button control to other machines in the shops wherever practicable. Railroad officers, in issuing authority for new shop machinery, may well consider the operating advantages of this remote control equipment. In fact, on one road the bids for the machine tools for a large new shop were actually recalled after the officers had been convinced that a mistake had been made in not including remote control apparatus for the electrically-driven units.

New Books

The Mechanical World Electrical Handbook. 388 pages, illustrated diagrams and tables, 4 in. by 6¼ in. Bound in cloth. Published by Emmott & Co., Ltd., 20 Bedford street, W. C. 2, London. Price 40c.

The present issue of this handbook contains a newly written section on electrical measuring instruments which describes the principal devices used in this connection. Another lengthy section is that which deals with plant, load and diversity factors. The notes on mercury rectifiers have been re-written and a new section introduced on power in alternating current circuits. The table on properties of electrical insulation materials is also included and minor additions have been made and several of the more prominent sections of the book revised generally.

An Erie Train Crossing a Bridge Over the Genesee River Near Rochester, N. Y.

Erie Replaces Steel Contact Wire with Bronze

The Railroad Was a Pioneer in the Use of 11,000 Volt A. C. Power—Much Valuable Experience Has Been Gained

NEW contact wire is being strung on the electrified section of the Erie Railroad which extends from Rochester, N. Y., to Mt. Morris, N. Y., a distance of 34 miles. The new wire will be strung from Rochester to Avon, N. Y., a distance of 19 miles. This division of the Erie was electrified at the same time as the New York, New Haven and Hartford between New York City and New Haven, Conn. Both roads use 11,000 volt alternating current and both roads are in a position to furnish valuable information pertaining to the design and construction of high voltage catenary systems.

Type of Equipment Used

The power distribution system consists essentially of a single catenary supported on wood and on steel poles except in yards where cross catenaries stretched between steel poles are used to support the main catenary, see Figs. 1 and 2. The main catenary is made up of three wires or cables, namely, a supporting messenger consisting of a 7/16-in. seven strand, galvanized Siemens Morgan high strength steel cable, a 3/0 solid copper auxiliary messenger and a 3/0 solid steel contact wire. The maximum height of the contact wire above the rail is 21 ft. and the minimum is 18 ft.

The auxiliary messenger is supported from the main or supporting messenger by space bars placed 10 ft. apart and the contact wire is supported from the auxiliary messenger by clips also placed 10 ft. apart and located half way between the space bars.

The poles are placed 120 ft. apart and fitted with brackets as shown in Fig. 1. A pin type insulator on the end of the bracket supports the messenger and a second pin type insulator, top mounted, holds a steady brace, Figs. 1 and 3, which keeps the contact wire from swinging. The current returns through the running rails.

There is one substation on the line located at Avon, N. Y., about half way between the terminals at Rochester and Mt. Morris. Power is purchased from the Niagara, Lockport and Ontario Power Company and is converted in the substation from 60,000 volts to 11,000 volts for use on the trolley. The frequency is 25 cycles. The three main power transformers in the substations have a rating of 750 kilovolt-amperes each and are oil insulated and water cooled.

There are eight motor cars and eleven trailers which, like the motor cars, are equipped with electric heaters. The motor cars weigh 98,000 lb. and are equipped with four Westinghouse type 132 railway motors.

Traffic

The train schedule includes 12 regular electric trains a day in each direction between Rochester and Mt. Morris. These trains vary from one consisting of a single motor car to one made up of two motor cars and eight trailers. The maximum current required at starting is 70 amperes per car or 140 amperes for a train including two motor cars. The normal running load is about 16 amperes per motor car. The greater part of the freight traffic is handled with steam locomotives. One of the motor cars is shown in Fig. 4.

Both freight and passenger service on the line is heavier between Rochester and Avon than between Avon and Mt. Morris. For this reason it is not yet necessary that the contact wire between Avon and Mt. Morris be renewed.

Experience in Catenary Design

As installed originally the catenary consisted of a 3/0 solid copper contact wire with a figure eight cross section supported by space bars as shown in Fig. 5 from a 7

strand galvanized steel messenger. This catenary was installed in 1906 and retained in service until 1913. A change was then made because of a fundamental weakness of the original design. It was found that the contact wire would move or creep longitudinally with relation to the messenger. This caused the space bars to assume a slightly inclined position with a consequent kink in the contact wire. As a result the contact wire broke frequently at points where it had been kinked.

Fig. 1—Typical Wood Pole Catenary Construction for Tangent Track

Fig. 2—Cross Catenaries Are Used Where There Are a Number of Tracks

Fig. 3—Steady Brace and Clamp

Fig. 4—One of the Motor Cars

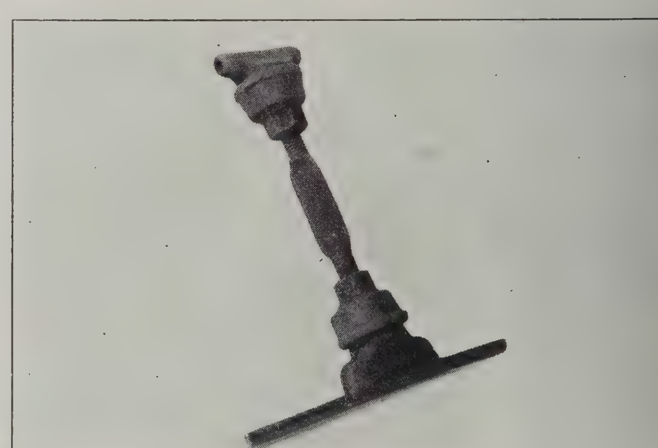


Fig. 5—The Original Catenary Consisted of a Contact Wire Supported by Space Bars From a Single Messenger

To correct this difficulty a 3/0 solid, figure eight steel contact wire was strung, supported from the old contact wire by clamp as shown in Fig. 6. As stated previously

the clamps are placed midway between space bars and are spaced ten feet apart.

The clamps are made of two pieces of galvanized steel held together by two 3/8-in. galvanized bolts. The volts are fitted with lock washers. The clamps are so designed that they grip the steel contact wire tightly, but will slide on the old contact wire which is now really an auxiliary messenger. A clear conception of the design of the clamps may be had by looking at the end view of the steady clamp, Fig. 2.

With regard to service and dependability the three-wire

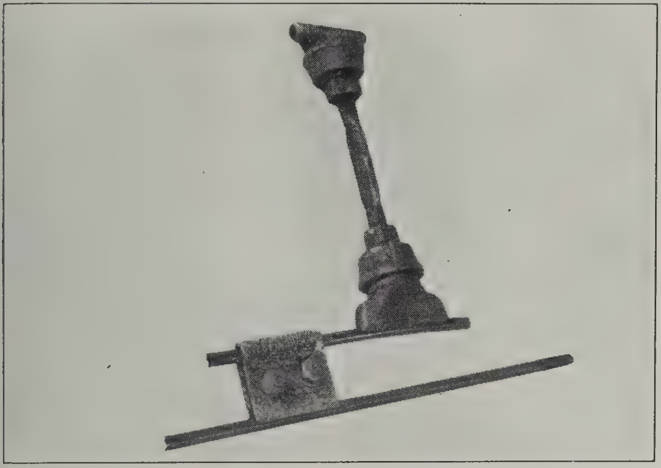


Fig. 6—The Addition of a New Contact Wire Greatly Improved the Catenary

catenary has been highly satisfactory. The steel wire was strung in 1913 and during its ten years in service it has broken only three times. The original wire was .438 in. in diameter and a typical sample of the wire measured recently had a diameter of .331 in. Samples of the contact wires are shown in Fig. 7. The sample at the left showing a section is a piece of the steel wire while the one at the right is a piece of the original copper contact wire. The amount of wear on the steel wire may be

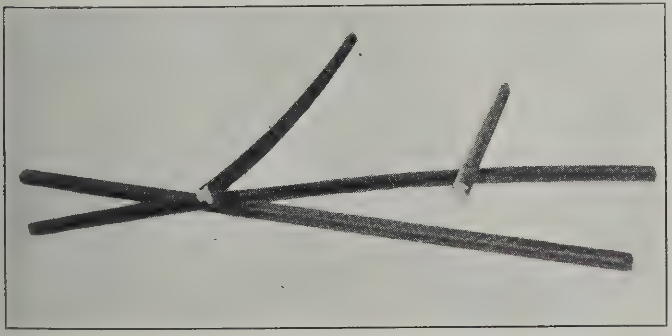


Fig. 7—Sample of the Steel Contact Wire and of the Copper Auxiliary Messenger Previously Used as a Contact Wire

seen to be large while that of the copper is comparatively small. The two samples below are steel and show the rusted condition of the wire. The supporting messenger will be serviceable for a number of years and there is practically no depreciation of the copper auxiliary messenger.

Phono-Electric wire is now being used to replace the steel wire. It was chosen primarily because of its high strength and wearing quality and because it will not rust. Its conductivity at 25 cycles is 60 per cent that of pure copper of equal cross section. The Phono-electric is 3/0 wire and has a figure eight cross section.

The principal objection to the steel contact wire is the rust which falls from the wire making the cars look

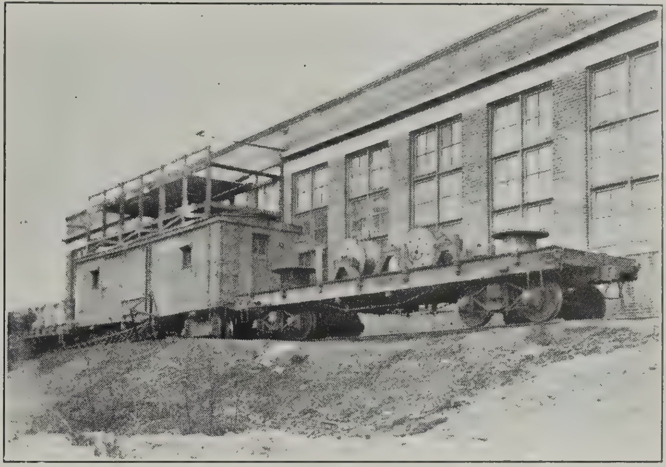


Fig. 8—Construction and Repair Train

badly in a relatively short time. It was also found that the steel wire increased the wear of the pantagraph shoes. A shoe that would run 15,000 miles on the copper contact wire ran only 5,000 miles on the steel. This, however, is not a factor of great importance as a pantagraph

Fig. 9—Stringing the New Phono-Electric Contact Wire

shoe cost only $2.30. The pantagraphs exert a vertical pressure of 8 lb. against the contact wire.

How the Wire is Strung

The work of stringing the wire is done at night between 1.00 A. M. and 6.00 A. M. which is the only time the traffic will permit taking the current off the line.

The construction train consists of an open top car, a box car, a flat car and a locomotive. The open top car is used for loading the steel wire that is taken down. There is a working platform mounted on the box car and the car is used to carry tools and a complete supply

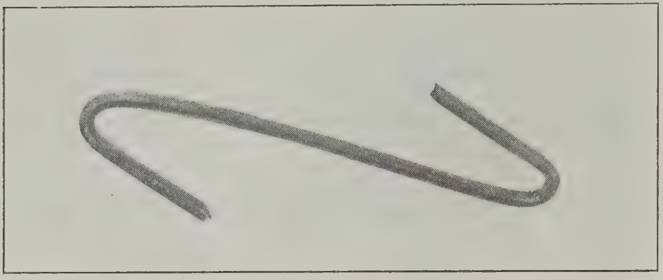


Fig. 10—A Sister Hook Made From Old Steel Contact Wire

of space bars, clamps, insulators and other extra parts. The flat car is used to carry the reels of Phono-Electric wire and the mountings for the reels. The locomotive is coupled to the flat car and when the work is in progress, the locomotive is used to pull rather than push the train. The front end of the locomotive is coupled to the flat car and light for the work is supplied by three acetylene flood lights and the locomotive headlight. There are seven men to do the work besides the train crew.

The first operation consists of taking the old contact wire down. The men on the platform take the clamps

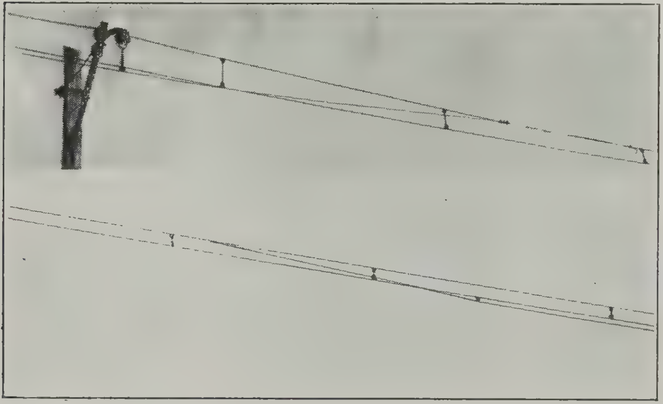


Fig. 11—Sections of the Overhead Showing How the Contact Wires Are Secured Temporarily to the Messenger So That the Trains Can Be Operated From the Auxiliary Messenger Without Interruption.

which hold the contact wire off with socket wrenches as the train is moved along. It is then cut up into lengths varying from eight to twelve feet with large bolt cutters and dropped into the open top car. About a mile of the wire is taken down at one time and the remaining contact wire is kept from running slack by clamping the end to the supporting catenary.

The second operation consists of stringing new contact wire. This work is shown in progress in Fig. 9. A jin pole with a pulley sheave at the top is erected and held with guys as shown. The new wire from the reel is run up over the sheave and is connected to such wire as has been strung previously with a Cleveland connector. The train then moves ahead steadily at a speed of from one to two miles an hour. Two men with a heavy plank, brake the reel so that the wire is quite taut as it is payed out. As the train moves along the men on the platform suspend the new wire from the supporting messenger with sister hooks (Fig. 10) made from short pieces of the old contact wire. These hooks are made up previously in varying lengths and are short enough so that as the new wire is payed out it hangs in a position above the auxiliary messenger or old contact wire.

There is about a mile of wire on each reel and after it is all payed out the end of the new wire is clamped to the supporting messenger. The wire is then pulled to the proper tension, first with block and tackle and finally with a turnbuckle. About half a mile of wire is pulled at a time and after the second pull the end of the new contact wire is again clamped to the supporting messenger.

The next and final step consists of removing the sister hooks and putting on the clamps which support the contact wire from the auxiliary messenger.

The fact that the auxiliary messenger was a contact wire before it was a messenger has proved an advantage in replacing the contact wire. After a length of the old wire has been taken down it often happens that there is not time enough left to replace it before the early morning trains must start. A section of the auxiliary messenger is then used temporarily as a contact wire and no special expedients need be resorted to to maintain regular service. The beginning and the end of a one mile section in which the auxiliary messenger functions as a contact wire are shown in the two halves of Fig. 11.

The work was carried on under the supervision of R. C. Thurston, electrical engineer.

Electrification of the railways of the Province of Quebec has been suggested recently by the Prime Minister of the Province. This has been made possible by the favorable Governmental handling of the problems in connection with water power development, an ample supply of this form of energy being available.

Falls of Atoyac on the Mexican National

Principles of Car Lighting By Electricity*

A Comprehensive Description of the Parts and Operation of the USL Type C Equipment and the P. R. R. Type

By Chas. W. T. Stuart

THE U. S. L., Type C, car lighting equipment, consists of a generator, driven by a belt from the car axle, a generator panel, a lamp regulator panel mounted in a cabinet inside or under the car body, and a storage battery which is suspended in a box under the car body.

The fundamental principle of the U. S. L. axle lighting system is modified constant potential with ampere-hour control. It differs from other principles in that the voltage coil is the dominating coil and its action is modified by the modifying coil as the charging progresses. At the point where the battery reaches a state of full charge, the ampere-hour meter comes into control and stops the charging process.

The lamp regulator is a device for controlling the voltage to the lamps, holding it constant between 30 and 31 volts when the generator or battery voltage is above that amount.

Generator

The generator, Fig. 2, is a four-pole, shunt-wound machine designed to give sparkless commutation with the varying speeds and varying loads met with in car lighting.

The U. S. L. generators are designed and built so that they may be used either for truck mounting or body mounting. For this purpose the frame of the generator is finished as a cylindrical body, and a certain portion of the convex surface is specially machined, drilled and tapped. By revolving the frame about its longitudinal axis through an angle of 180 degrees, it may be adapted to either truck or body mounting.

For truck mounting two steel adapters bolted to the frame provide the four supporting feet, see Fig. 3. The two lugs for body mounting are provided in the form of a saddle casting which is bolted to the frame, as shown in Fig. 4.

The U. S. L. generator consists of the following main parts: magnet frame, pole pieces, field coils and retainers, armature, bearings, combined pole changer and brush rigging and brushes.

The magnet frame is a one-piece steel casting. The housing heads which carry the bearings are bolted to the magnet frame at each end. Hand holes, with water and dust-proof covers, are provided at the commutator end for inspection purposes.

The pole pieces are of the laminated type and bolted to the magnet frame. The armature is form wound with conductors having heat-proof insulation. The coils are held in the core slots by band wires. The armature core is built up of transformer iron laminations, and air spaces are provided in the core to secure cool running. The commutator bars are of hard drawn copper with liberal wearing depth and ample area to carry the maximum output of the generator. The armature shaft is made from high-grade steel accurately ground to size. The pulley in addition to having a tapered seat, is keyed to the shaft and locked with a Columbia lock nut. The bearings for the armature shaft are annular ball bearings, of a type especially developed for this service.

A space is provided around the bearings for grease for lubrication. Grease grooves and felt washers prevent the entrance of dirt into the bearings and the leakage of grease into the portions of the generator where it should not go.

The pole changer is of the rotating type, the direction of the current from the generator being kept constant by rotating the brushes through an angle of 90 degrees whenever the direction of rotation of the armature is changed.

The four brush boxes are mounted on a brush rocker and are insulated from it by fibre insulators. This brush rocker is mounted on a ball bearing and is free to rotate between two stops 90 degrees apart. While running in one direction, the friction caused by the pressure of the brushes against the commutator holds the brush rocker against one of the stops, the brushes being in the proper position for the sparkless commutation for this direction of rotation. Reversing the direction of rotation causes the brush rocker to be turned over against the other stop, changing the position of the brushes 90 degrees. The generator then gives the same polarity, although the direction of rotation has been reversed.

The brushes are made of carbon and provided with flexible copper pigtails to give positive contact with the brush box. Each brush is provided with a separate pressure spring of such design that the pressure on the brush is constant until the brush reaches its limit of wear.

Type C Generator Regulator Panel with Ampere Hour Meter

The generator regulator panel, Fig. 1, consists of a slate panel on which are mounted the automatic switch, field rheostat or carbon pile, regulator adjustments, solenoid with its respective plunger and connecting lever arms, main and field fuses, and Sangamo ampere-hour meter.

The automatic switch is of the solenoid type, consisting of a fine wire shunt or lifting coil, a series of releasing coil of heavy copper strip, plunger, main and auxiliary contacts. See schematic Diagram, Fig. 5. The main contacts of the switch are at the bottom, but at the top an auxiliary contact switch is operated by the same plunger, which opens when the main contact closes. This auxiliary switch puts resistance in series with the lifting coil, which reduces the current in the lifting coil considerably. By having this resistance cut into the series coil when the main switch is closed, the following advantages are obtained: The lifting coil is connected directly across the armature circuit and exerts a maximum pull at 32.5 volts before the switch is closed. The resist-

* This article supplements a previous description of U. S. L. Equipment which was published in the *Railway Electrical Engineer* for August, 1921. In the near future all of the articles which have appeared in this series—*Principles of Car Lighting by Electricity*—will be published in book form.

ance in series with the lifting coil keeps it from over heating at high generator voltages. Also the increased resistance in the lifting coil circuit insures a quick release of the automatic switch, because the coil is so weak that

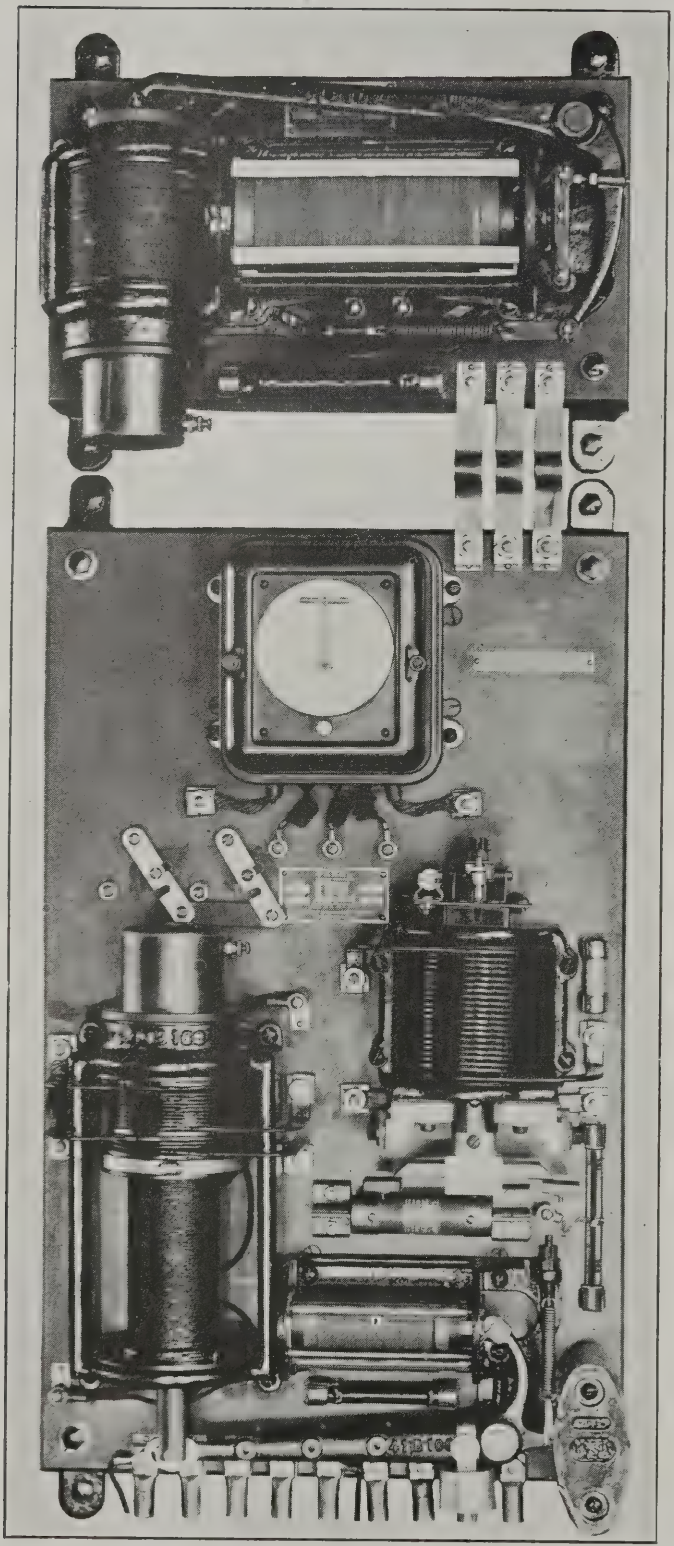


Fig. 1—Type C Panel with Type B Lamp Regulator

only a little reverse current in the series coil is necessary to open the switch. The field rheostat or carbon pile is connected in series with the field circuit. The resistance of the carbon pile is automatically adjusted by movement of the plunger of the regulating solenoid. The regulating solenoid consists of two coils, a modifying or series winding which is connected in series with the ampere-hour meter and the battery, and a shunt winding which is connected across the generator terminals and in series with a variable resistance.

The modifying or series coil will regulate the current delivered by the generator to the battery to a certain value. to increase the battery charging rate one or more shunt strips of resistance ribbon are connected across the

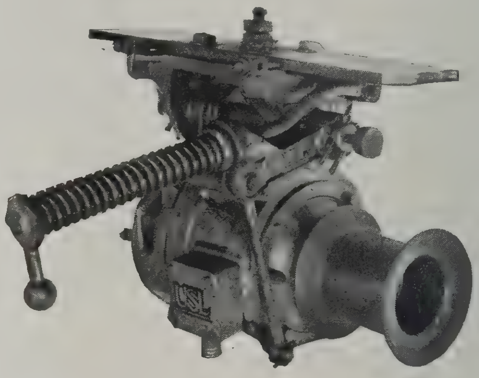


Fig. 2—Type C Generator

modifying coil on binding posts provided for this purpose.

The shunt winding when acting alone actually maintains a constant generator voltage. If this voltage rises, the current through the coil increases, the upward pull of the plunger which is connected to the field carbon pile through the lever, increases, diminishing the pressure on the field carbon pile, so that the generator field is weakened, the result being to lower the generator voltage to its

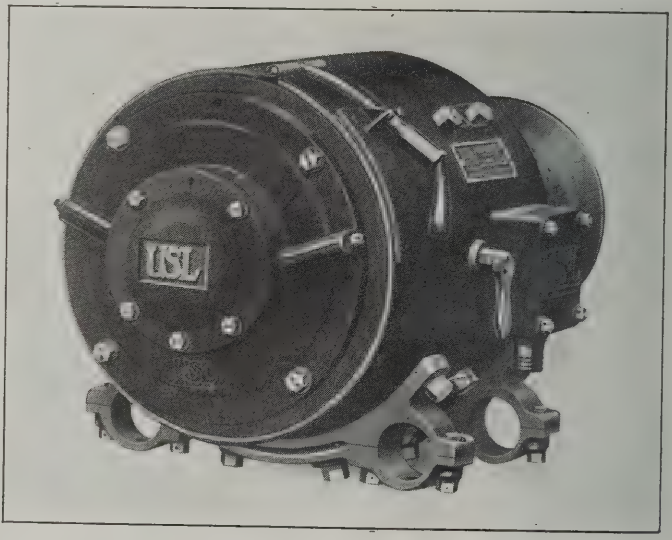


Fig. 3—USL Generator with Foot Adapter

former value. A decrease in the generator voltage produces a correspondingly opposite effect.

An adjustable resistance is connected in series with the shunt coil as a means of adjusting the operating voltage of the coil.

The ampere-hour meter is equipped with a zero contact. When the hand of this meter returns to zero, indicating a full charge, it closes this contact, which short circuits a resistance in series with the regulator shunt coil. This action lowers the generator voltage and the battery floats on the line.

Type B Lamp Regulator

The type B lamp regulator, Figs. 1 and 6, consists of a carbon pile and a solenoid having a vertically mounted and operated plunger which, through a compound lever mechanism, varies the pressure on the column or stack of carbon discs. The normal pressure on the carbon discs is supplied by means of a spring attached to the lower end of the vertical member of the bell crank lever, the other end being attached to a stud carried in a bracket

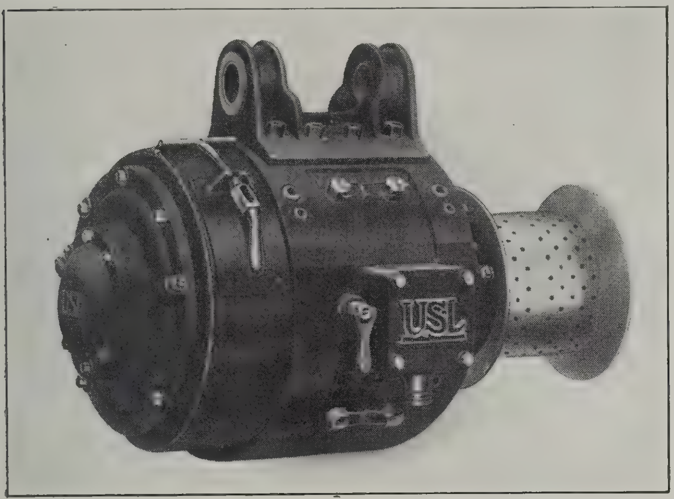


Fig. 4—USL Generator with Hanger Adapter

which forms an integral part of the surbase. A castellated nut on this stud permits adjustment of the spring tension.

The main lever, which is of bell crank form, having horizontal and vertical portions, is mounted by means of a ball bearing on a stud secured to a heavy boss which forms a part of the surbase. A small vertical lever, provided with two rollers, is also mounted on a stud and boss, forming part of the surbase. The lower roller bears upon

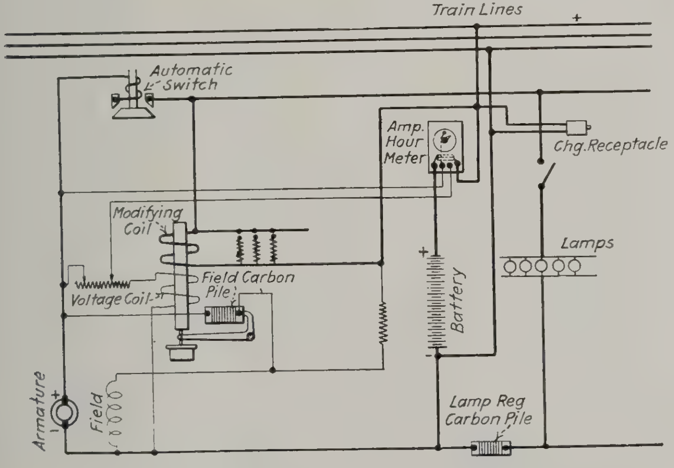


Fig. 5—Schematic Diagram Type C Panel

the stud of the thrust plate, which imparts pressure to the carbon pile. An adjusting screw, which passes through the vertical portion of the bell crank lever, imparts motion to the upper roller in the end of the vertical lever, to the latter. The carbon pile is supported by means of two lower support rods and held in place by means of two upper similar rods, these rods being insulated by means of lavite tubes. These rods are easily removable by means of the thimbles which are screwed into the right hand member of a carbon pile supporting bracket. The carbon pile is confined between two thrust plates, the left hand thrust plate being stationary and insulated from the frame of the regulator, the right hand thrust plate being movable and likewise insulated, and being provided with a horizontal stud which passes through a graphite bushing supported by the right hand member of the carbon pile bracket.

The right hand thrust plate is provided with a compression spring which moves the thrust plate in such a direction as to relieve pressure on the carbon pile, the function of this spring being to cause the thrust plate to follow the releasing motions or movements of the lever mechanism. This construction of movable thrust plates insures a frictionless movement of the same and one that maintains the exact parallelism of the thrust plate at all times.

The entire carbon pile bracket may be quickly removed from its position and by the disconnection of the flexible leads or pigtails of the thrust plates, the whole carbon pile

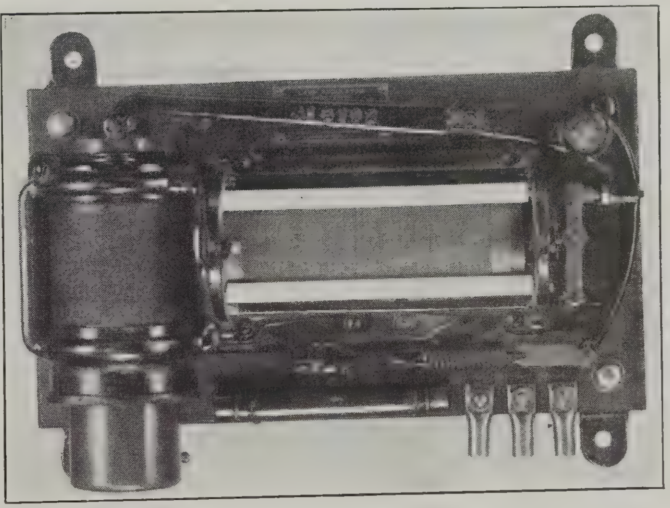


Fig. 6 (a) Type B Lamp Regulator for Normal Loads

system may be removed for inspection or renewals without disturbing the lamp regulator.

The solenoid frame may also be removed from the surbase without taking down or disturbing the lamp regulator, which constitutes a very important feature of construction in this class of apparatus. The solenoid frame is provided with a standard bakelite dashpot for the purpose of damping out slight fluctuations.

The lamp regulator, as shown in Fig. 1, is arranged with three main terminals on the lower margin of the slate to the right of the center, which register with three terminals, which will be found on the upper margin of all standard panels, to the right of the center. This is so that the lamp regulator may be mounted above the panel and connected to the system by simply joining the three terminals on a lamp regulator with the corresponding three terminals on the panel.

The only two adjustments of the type B lamp regulator are made by means of screws, all resistance units being fixed in value. These adjustments are in the screw of the vertical portion of the bell crank lever and in the nut on the tension spring stud. By means of these two adjust-

ments the lamp regulator may be fully adjusted. The type B lamp regulator, Fig. 6 (a), is designed for normal lamp loads. For extra large loads the type C lamp regulator, Fig. 6 (b), is used.

Operation

Fig. 5 is a wiring diagram of the U. S. L. equipment and the operation is as follows:

When the car is standing and generator inoperative the current to the lamps is furnished by the storage battery.

When the car is in motion the generator voltage will build up due to the magnetism of the field pole pieces. At slow speed there is generated in the armature a low voltage which forces a small amount of current through three parallel circuits comprising the automatic switch lifting coil, the field circuit, and the voltage coil of the generator regulator solenoid.

As the speed of the armature increases and the current in the field circuit increases the field magnetic strength and the generator voltage also increase until it reaches 32.5 volts, at which time the automatic switch should close and connect the generator to the car wiring. The instant the automatic switch closes, all circuits become energized, the machine furnishing current for any lamps that may be turned on but delivering only a small amount of current to the battery. As the speed increases the generator voltage rises and increases the battery charging current until it reaches its maximum value. Assume the battery to be in a discharged condition, and the regulator con-

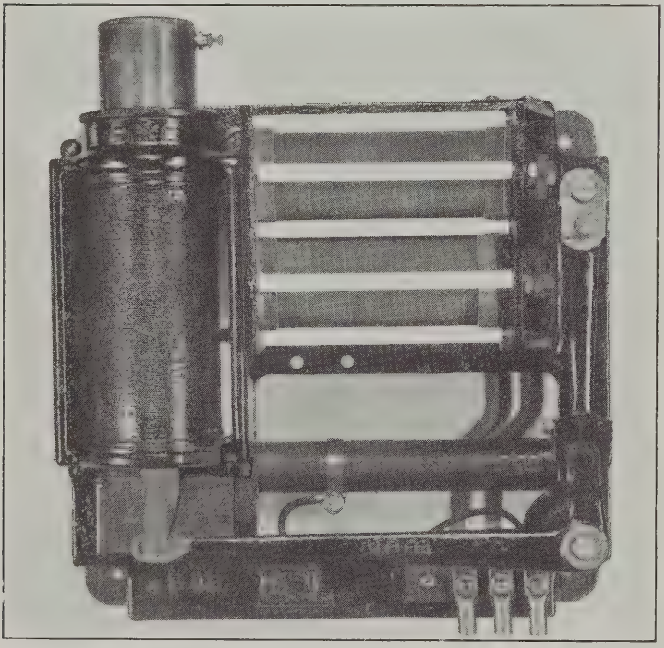


Fig. 6 (b) Type C Lamp Regulator for Extra Large Loads

nected for the battery charge regulation. The maximum battery charging current referred to is held nearly constant and passes through the series or modifying coil of the generator regulator solenoid. At this point it must be remembered that both series and shunt soils of the generator regulator solenoid are alive and operating or exerting their effect on the solenoid plunger. As above stated the series or modifying coil maintains the battery charging current nearly constant with a battery in a discharged condition. As the battery charges its voltage rises. Then the generator voltage is raised by the action of the modifying coil until the charging current again reaches its maximum value. This continues until the battery voltage rises to the point where the potential coil overcomes the effect of the modifying coil. Thereafter the potential coil maintains practically constant generator voltage and the charging current gradually tapers. This principle of regulation is strictly a modified constant potential and is governed by the e.m.f. of the battery. At the beginning of charge the charging current is fairly heavy, but as the charge progresses it tapers to about one-half its initial value in eight hours. This rate con-

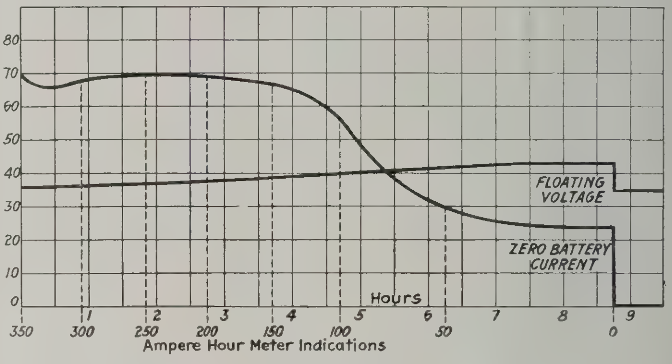


Fig. 7—USL Ampere-Hour Controlled Battery Charging Curve

tinues until the ampere-hour meter hand returns to zero, indicating a full charge, at which time the contact closes and the generator voltage is reduced to a floating value, the current charging current dropping to zero. The floating voltage for a 30-volt system is 35 volts, with lead battery.

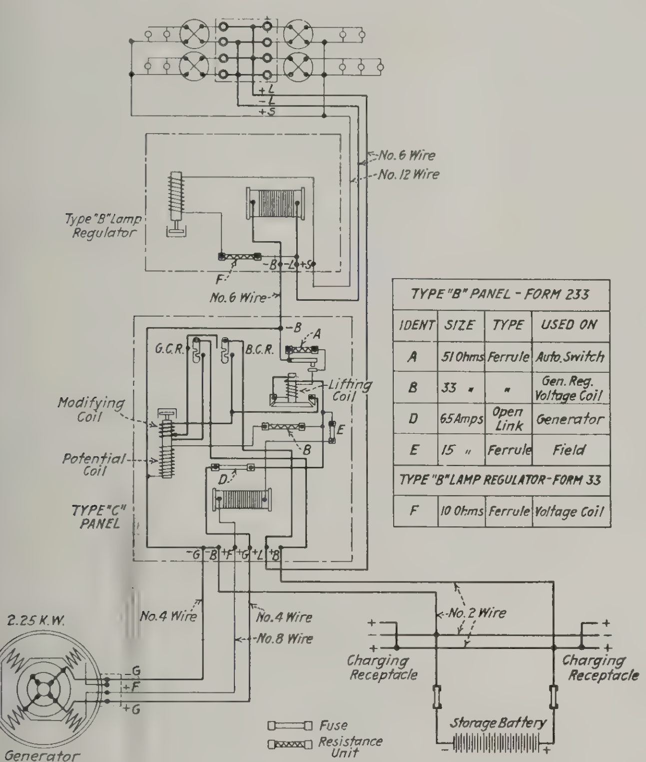
During the battery floating period the generator regulation is straight constant potential. There is one other condition at which the regulation becomes constant potential and that is when there is an open battery circuit before the ampere-hour meter has acted. Under this condition the voltage coil will regulate at 45 volts and as there is no current flowing in the battery circuit the modifying coil has no effect.

This is best illustrated by means of a curve, Fig. 7. Here it will be seen that the current started at seventy amperes and gradually tapered until during the fourth and fifth hours the current was rapidly falling, assuming finally a value of about 24.5 amperes at the end of the ninth hour, which is then reduced to zero by operation of the ampere-hour meter.

Referring again to the charging curve, Fig. 7, it is assumed that at the beginning of charge the ampere-hour meter hand stood at 350 ampere-hours, indicating that the battery had previously had 350 ampere-hours taken out of it. It will be seen that the area under the charging current curve is 437.5 ampere-hours, which was put into the battery in 8.75 hours, or at an average rate of 50 amperes, being 70 at the start and 24.5 at the finish. As it would require 437.5 ampere-hours put into the battery to get 350 out next time, the ampere-hour meter is so arranged that it will require the passage of 350 ampere-hours to drive the hand back from 350 to 0. At the end of 8.75 hours the hand of the ampere-hour meter has been driven back to zero and the contacts brought together. These contacts short circuit a portion of the resistance in series with the voltage coil of the generator regulator and thereby strengthen the voltage coil, which has the effect

of reducing the generator voltage. So that just at the termination of the charge of 437.5 ampere-hours at the end of the eighth hour of continuous charging, the ampere-hour meter comes into control and stops the charging process by reducing the generator voltage to floating value, 35 volts on a 30-volt system. The voltage drops suddenly from 43 to 35 volts and the finishing and reduced charging current from 24.5 amperes to zero. This condition exists until after a 50 ampere-hour discharge from the battery, when the meter contacts will open.

The lamp current does not flow through the modifying



TYPE "B" PANEL - FORM 233			
IDENT	SIZE	TYPE	USED ON
A	51 Ohms	Ferrule	Auto. Switch
B	33 "	"	Gen. Reg. Voltage Coil
D	65 Amps	Open Link	Generator
E	15 "	Ferrule	Field
TYPE "B" LAMP REGULATOR - FORM 33			
F	10 Ohms	Ferrule	Voltage Coil

Fig. 8—Wiring Diagram of USL Equipment—P. R. R. Specifications

coil and consequently has no effect on the regulation or rate of battery charging, the lamp load is picked up by the generator alone, when it is running.

Adjusting Automatic Switch

The laminated copper contact of the automatic switch should be adjusted in the stirrup so that when the plunger is lifted this laminated copper contact makes perfect contact with the stationary contacts on the switch frame. When the plunger is lifted and pushed home the copper leaf brush should bend but slightly. Allow plunger to drop and again raise it so that the brush comes within 1/16 in. of making contact. Adjust the side carbons by means of the cap screws so that they just rest upon the carbons attached to the phosphor bronze leaf spring, when the plunger is in this position. See that the short leaf spring of the auxiliary contact at the top of the switch just makes nice contact with the auxiliary lever when the switch is in its lower position. See that the point of the stud in the auxiliary lever enters the hole in the copper strip. This stud should be adjusted so that the auxiliary contact is broken just at the moment the carbons come in contact. The castellated nut on the tail rod of the top of the switch should be adjusted so that with 32.5 volts impressed upon the lifting coil of the switch the latter will close. This may be done by making the distance from the top of the stirrup to the key which prevents the plunger from turning and holds the tube in place, ⅝ in. to ¾ in. This adjustment should be checked when the apparatus is in operation.

Adjusting Generator Regulator When Not in Operation

Examine the field carbon pile and see that the proper number and size of carbon discs are in place. Examine support rods and tubes carefully to see that none are bent or broken. See that the plunger and lever mechanism work freely without binding or sound. See that when carbons are compressed the whole pressure comes upon the carbons and that no parts of the moving mechanism are arrested by coming into contact with stationary members. This is best done by opening the dash pot vent wide. The lever mechanism when moved up and down by hand should bounce on the carbon pile when released quickly.

Testing Type B Lamp Regulator

Examine the carbon pile and see that it contains 32 discs 2⅜ in. in diameter and 3/16 in. thick. The carbon pile should measure six inches in length when compressed. Open dash pot vent and work lever up and down by hand to see that mechanism is free from sticking and sound. The conical compression spring under armature disc requires 8 to 12 pounds pressure. It should be rejected if these limits are departed from. The dash pot should be removed and the piston unscrewed from the plunger tail rod. Set dash pot on level surface. Insert the piston

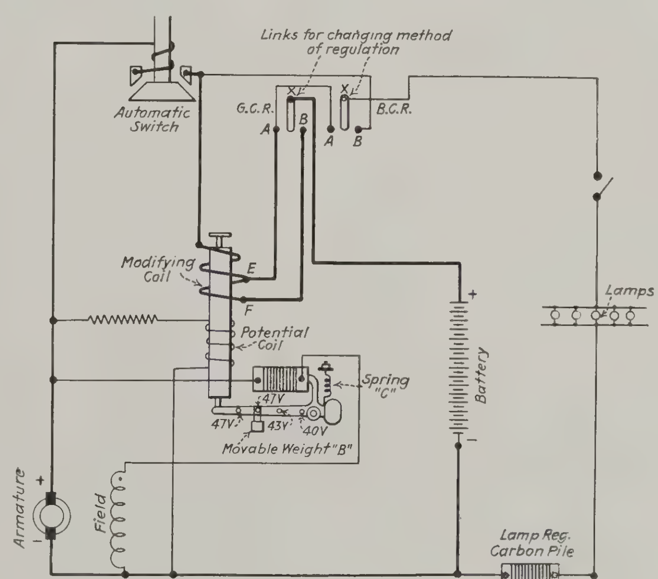


Fig. 9—Type C Panel—Schematic Diagram P. R.R. Specifications

until top of piston and pot are even. Close vent tightly. Release piston and time descent, which should require from 45 to 60 seconds. Replace piston and dash pot. Replace carbons if they have been removed and adjust screw in vertical member of bell crank lever until its long arm just begins to move downward. (About 1/64 in. at top of solenoid). This insures pressure being on discs at all times. Turn on smallest lamp load likely to occur and adjust tension spring nut until voltage on lamps is 31.

It is well to allow lamp regulator to run with full load

for half an hour before final adjustment is made, as the adjustment should be made with regulator fairly hot. The short auxiliary lever should stand nearly vertical when adjustments are completed. This adjustment should be checked when equipment is in operation with different lamp loads.

Testing and Adjusting Type C Regulator

With the generator operating and lamps turned off check the automatic switch closing voltage. If correctly adjusted it will close at 32.5 volts. If it closes before 32.5 volts are reached unscrew the nut on the tail rod and increase air gap in switch, or if it does not close until after 32.5 volts are reached, screw up on this nut and lock with cotter pin after correct adjustment has been secured. By carefully raising and lowering the lever of the generator regulator, the generator voltage may be varied at will and the adjustment of the automatic switch tested completely. The automatic switch should open when the voltage has dropped to about 27 volts and the ammeter should indicate about 5 amperes reverse or releasing current.

Turn hand of ampere-hour meter beyond 50 to be sure contacts are open. Now raise lever of generator regulator until ampere-hour meter disc comes to a dead stop, and then open battery circuit. If there is no battery switch, disconnect positive battery wire at bottom of panel. Slowly lower lever, observing voltage. Remove hand from lever and slide right hand slider on resistance unit at top of panel to extreme right hand position. The voltage should be about 50. Now move slider to left until voltage is reduced to 45. This is the open battery voltage adjustment and is to remain. Now turn hand of ampere-hour meter to zero to close contacts and observe reduction in voltage. Adjust left hand slider until voltage is exactly 35. This is the floating voltage corresponding to zero current through battery as battery circuit is open. Turn hand again beyond fifty and observe that voltage goes back to 45. Now close battery circuit and observe that voltage drops to an intermediate value between 35 and 45, and that battery takes a charging current. Make no further voltage adjustments.

Set the hand of the ampere-hour meter so that the meter is in step with the battery. Now refer to Fig. 7 showing the charging curve of the panel and battery. Run along the bottom line marked meter scale until the setting of the ampere meter is found. Then run vertically up to the charging curve and read the number of amperes on left-hand vertical scale. Compare ammeter with this number. If ammeter reads less add shunt strips to modifying coil or panel until ammeter reads correctly. If ammeter reads more remove shunt strips until correct current flows. The panel is now adjusted and the battery and ampere-hour meter are in step. When the battery becomes fully charged, the ampere-hour meter hand will come to zero, the contacts close, the voltage will reduce to 35, and the battery will stop charging and float in the line. The generator will carry the lamp load independently of these conditions.

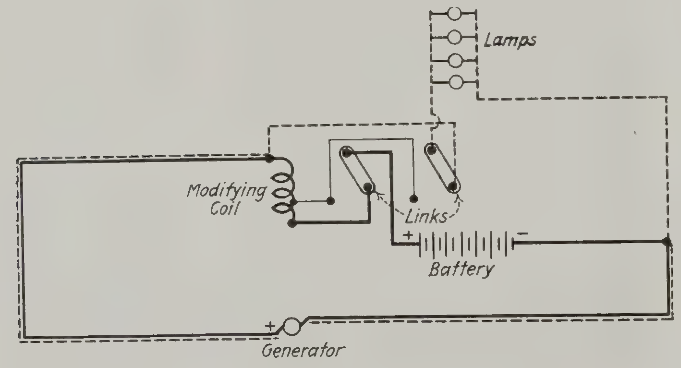


Fig. 10—Schematic Wiring Diagram of Main Circuits—Links to Right for Battery Current Regulation—Heavy Lines Shows Path of Charging Current from Generator Through Modifying Coil, Link and Battery Back to Generator—The Path of the Lamp Current is Shown by Dotted Lines—Note That the Lamp Current is Direct from Generator to Lamps and Does Not Pass Through Modifying Coil.

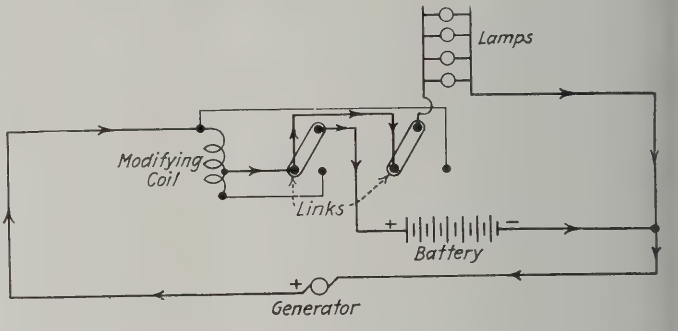


Fig. 11—Schematic Wiring Diagram of Main Circuits—Links in Left Hand Position for Generator Current Regulation—Current to Battery and Lamps Shown by Arrows.

U. S. L. Equipment (P. R. R. Specifications)

The U. S. L. equipment (P. R. R. Specifications) consists of a Type CBH Form 17 generator, Type C. P. Form 233 generator regulator, Type B Form 33 lamp regulator, and type A-4-H Edison battery. The generator is a four-pole, shunt wound machine, rated at 2.25 kw. 45 volts and representing a generator capacity of 50 amperes. This generator has a cutting in speed of 250 r.p.m. and a full load speed of 333 r.p.m. On a car equipped with 36 in. wheels and an 18 to 8 reduction, that is, 18 in. axle pulley and 8 in. armature, this generator will cut in at a train speed of 12 miles per hour and carry full load at a train speed of 15.9 miles per hour. It will also operate safely at a train speed of 75 miles per hour with wheels worn to the limit. Therefore, this equipment is suitable for either branch line service where the train speeds are low or main line service where higher train speeds are attained.

The armature weighs 160 lb.; the generator complete weighs 680 lb.

Generator Regulator.—The generator regulator. Fig. 3, consists of a slate panel on which are mounted the automatic switch, field rheostat or carbon pile, regulator solenoid, with its plunger and lever arms, a main and field fuse, and adjustable links.

The automatic switch is the same as previously described.

The field rheostat is connected in series with the field and contains approximately 93 discs, which are 1/32 in. thick and 1½ in. diameter. The resistance of this pile is automatically adjusted by movement of the plungers of the regulating coils. The solenoid consists of two coils, a potential coil and a series modifying coil.

The adjustable links are used for connecting the regu-

lator for either generator current regulator or battery current regulation.

The resistance unit in series with the potential coil has a resistance of 33 ohms.

The pull of the regulator solenoid plunger is opposed by a spiral spring and a movable weight attached to the lever arm.

Lamp Regulator.—The type B U. S. L. lamp regulator is used with this equipment and has been previously described in this article.

Storage Battery.—The storage battery used with the U. S. L. equipment (P. R. R. specifications) consists of 25 type A-4-H Edison cells. This battery is assembled in five trays, five cells per tray, and has a capacity of 150 ampere-hours.

The lead storage battery may also be used with this equipment.

Operation.—Fig. 8 is a wiring diagram of the U. S. L. equipment (P. R. R. specifications) and the operation is as follows:

When the car is standing and the generator inoperative, the current to the lamps is furnished by the storage battery. When the car is in motion, the generator voltage will build up, due to the residual magnetism of the field pole pieces. At slow speeds there is generated in the armature a low voltage which forces a small amount of current through three parallel circuits—the lifting coil of the automatic switch, the field circuit, and the potential coil.

As the field of the generator is increased, and the current in the field circuit increases the field magnetism strength, the generator voltage also increases until it reaches 32.5 volts, at which time the automatic switch should close and connect the generator to the car wiring.

The instant the automatic switch closes all circuits become energized, the machine furnishing the current for any lamps that may be turned on, but delivering only a small amount of current to the battery. As the speed increases the generator voltage rises and the generator current increases until the regulating solenoid goes into operation. The generator regulator is what is known as the modified potential type which has been previously described. This equipment, however, does not have the ampere-hour control, and the charging current when the battery is fully charged tapers to approximately 10 amperes. In addition to this, the regulator is designed so that it will either regulate the battery charging current or the total generator current. With the first method known as "battery current regulation," the battery current flows through the entire modifying coil, and all lamp current will simply be added to the generator load, without affecting the amount of charging current. With the second method "generator current regulation" the total useful current, that is, battery charging current plus lamp load, will flow through a section of the modifying coil. The entire modifying coil is not used for this method of regulation. The change from one method of operation to the other is made by throwing two links. The schematic diagram, Fig. 9, shows how this change is made. When the links are to the right and connected to terminals *B*, Fig. 9, the modifying coil controls, up to a point, the battery charging current and the lamp load is picked up by the generator because the positive lamp tap is made on the generator side of the modifying coil, which means that no lamp current flows through that coil. This is further illustrated in Fig. 10. The path of the lamp current is shown by dotted lines, while that of the battery is shown by heavy lines.

When the links are to the left, and connected to terminals *A*, as shown in Fig. 11, the positive side of the lamps is connected to the battery side of the modifying coil so that both lamp and battery current flows through the coil.

So far, we have considered the modifying regulating feature. The potential coil of the regulator solenoid has four settings. A movable weight is hung from the lever arm and may be fixed at any one of the four points, as shown in Fig. 9. The four settings, reading from the left are 47, 45, 43 and 40 volts, respectively. When this equipment is used with the type A-4-H, 150 ampere-hour Edison battery, the weight is set for 43, 45 or 47-volt regulation, according to the season of the year. The setting, when used with lead battery, is 40 volts.

Generator Regulator Adjustments.—The automatic switch adjustment has been previously described.

The field carbon pile contains the proper number of carbon discs when the distance from the top of the solenoid frame, with a dashpot removed, to the top of the plunger (not the tail rod) measures 2⅞ in. The regulator tension spring *C* is adjusted at the factory and the movement of the movable weight *B* from one point to another should give the correct setting. However, should it be necessary, the voltage setting may be adjusted as follows:

With the generator operating and the weight *B* in one of the four positions, hold the automatic switch open and adjust the tension of the spring *C* until the regulated open circuit voltage is approximately 5½ volts above the operating voltage setting, with the regulator coils hot. For example, to adjust the operating voltage to 43, you would adjust the open circuit voltage with regulator coils hot to approximately 48½ volts.

The Austrian electrical industry is withstanding the period of deflation better than most others in that country. One of the leading Vienna factories had been running fully employed until last November, since when, between 300 and 400 have been gradually discharged. Those remaining, however, are at present working full time.

Ore Loading Station, Lulea-Riksgransen Line, Sweden

Two Electrical Reports at the A. R. A. Convention

Electric Rolling Stock, Car and Locomotive Lighting Discussed at June Meeting in Chicago

AT the recent convention of the Mechanical Division of the American Railway Association two reports of primary interest to electrical men were presented. The reports were those pertaining to electric rolling stock and to locomotive and car lighting. The reports are here given together with an abstract of the discussion which followed:

Report on Electric Rolling Stock

The committee submits the accompanying rules for the maintenance of electrical equipment, both locomotives and cars, in such general terms that rules covering local conditions can be added to them, and recommends consideration of these rules as the recommended practice of the Mechanical Division of the American Railway Association.

Instructions for Maintenance of Electrical Equipment of Rolling Stock

These instructions are based, in general, on the experience and actual practice of those roads having electrically equipped rolling stock. They are offered as suggested practice for other roads having equipment of this character. It should be understood, however, that the requirements are not binding and may be modified in any respect to suit the local conditions on the roads adopting them. Inasmuch as these instructions necessitate the performance of work on electrical apparatus and circuits, attention is called to the fact that such additional instructions, as may be necessary, must be issued to insure that the work is performed in such a manner as to avoid personal injury to the workmen.

1. Such parts of these instructions as are applicable to any class of equipment, shall be considered to apply to that class of equipment.

2. The periods of regular inspection shall be as follows:

(a) *Locomotives*—Every 2,500 miles, or such other mileage as may be considered suitable.

(b) *Multiple Unit Cars*—Every 1,500 miles, or such other mileage as may be considered suitable.

3. The periods of heavy inspection shall be as follows:

(a) *Locomotives*—Every 10 regular inspections.

(b) *Multiple Unit Cars*—Every 10 regular inspections.

4. The periods of class repairs shall be as follows:

(a) *Locomotives*—Every 150,000 miles.

(b) *Multiple Unit Cars*—Every 100,000 miles.

5. At regular inspections the following work shall be performed:

Main Motors—(a) Inspect motors for mechanical and electrical condition. (b) Gage with feelers the mechanical clearance between armature and pole faces to determine wear of armature bearings; also check lateral movement of armature. (c) Clean commutator and string band. (d) Inspect brushes and brush shunts to determine that brushes are properly seated on the commutator and fit the brush holder, that the brushes do not have copper embedded in the contact face, that the shunt connections are tight and shunts are not broken. Repair defects or renew brushes or shunts. (e) Lubricate armature and axle bearings. (f) Examine air connections and repair defects. (g) Inspect motor nose suspension, gears and pinions, and repair if necessary. (h) Blow out all dirt with dry compressed air. (i) Test insulation resistance with 35,000-ohm magneto, or 1,000 volts to ground for one minute, for short circuits and grounds.

Main Motor Wiring, Including Bus Jumpers—(a) Inspect motor circuit wiring and conduit for mechanical defects and defective insulation. See that all connections are tight. Repair all defects found. (b) Test all motor circuit wiring and connected apparatus, such as rheostats, circuit breaker, switches, etc., with 35,000-ohm magneto, or 1,000 volts to ground for one minute, for short circuits and grounds. Repair all defects found.

Rheostats—(a) Inspect all rheostats for broken grids and loose connections. Repair all defects found. Test rheostats with 1,000 volts for short circuits or grounds.

Circuit Breakers—(a) Clean circuit breaker and inspect contacts and connections. Clean insulators. Dress or renew defective contacts. Inspect supporting bolts and insulators. Test operation, including re-set and tripping device. (b) Where oil circuit breakers are mounted outside of car or locomotive, it will probably be necessary to change the grade of oil in winter and summer. This should be done at the nearest regular inspection.

Reverser—(a) Clean reverser and inspect contacts and connections. Dress or renew defective contacts. Clean insulators. (b) Inspect magnet valves and clean or adjust as needed. (c) Test to see that reverser operates properly.

Switch Group or Contactors—(a) Clean switches and if necessary renew or dress contacts. Examine arc chutes and repair or replace sides if necessary. Wipe off insulator. (b) See that all connections are tight. (c) Examine and clean interlock contacts, examine fingers for tension and adjust if necessary. (d) Inspect magnet valves and clean or adjust as needed. (e) Test to see that switches operate properly.

Transformer and Impedance Coils—(a) Examine connections for mechanical condition. See that connections are tight. Repair all defects. (b) Examine air connections and repair defects. (c) Blow out ducts with compressed air.

Pantagraphs and Connections—(a) Examine shoes and horns, replacing if necessary. (b) Examine hinges, tubing, links, etc., for wear or defects. (c) Examine shunts and connections for signs of heating or breakage. (d) Examine hoses for leakage or weakness. Wipe off insulators and see that they are in good condition. (e) Test operation. Gage height of low voltage pantagraphs. See that high voltage pantagraph pressures are within required limits.

Trolley Pole and Parts—(a) Inspect trolley base, pole, harp and wheel. Straighten or renew bent or defective

poles. Adjust contact tension between harp and wheel if needed. Renew defective wheels. (b) Inspect trolley rope and retriever. Renew rope and repair or renew retriever as needed. (c) See that all parts operate properly.

Third Rail Shoe Beams and Brackets—(a) Inspect third rail shoe beams and brackets for split or broken beams, and broken or loose bracket bolts. Tighten bracket bolts or renew defective parts.

Third Rail Shoe Leads—(a) Inspect third rail shoe leads, connections and conduit. Tighten connections and renew defective parts.

Third Rail Contact Shoes—(a) Inspect third rail contact shoes. Renew worn or broken shoes. (b) Gage third rail contact shoes to see that they are in proper position in both vertical and horizontal planes. Adjust to correct position if necessary. (c) During and immediately prior to cold weather, examine extra pressure devices and sleet scrapers, maintaining them in first class condition. (d) Examine, test, and gage automatic train stops, repairing any defects found.

Third Rail Shoe and Other Fuses—(a) Inspect fuses, fuse blocks and supports. See that proper number of fuses is in each box. Repair or renew if defective. (b) Test fuse clamp operation to see that it works freely.

Knife Switches and Grounding Switches—(a) Inspect to see that blade meets jaws squarely; that contact surfaces are smooth and make contact all over with proper pressure. (b) Inspect operating mechanism, if any, and see that it operates properly. (c) Inspect connections to see that they are secure and show no signs of heating.

Trolley Lightning Arrestor and Ground—(a) Inspect trolley lightning arrestor. Repair, renew or tighten as may be necessary.

Conduit Carrying 600-Volt Wiring Inside Car—(a) Inspect grounds and test with bank of lamps to make sure the conduit is properly grounded.

Main and Regenerative Control Circuits and Electrical Connections to Air Brake Apparatus, Including Jumpers—(a) Inspect control circuit, and electro-pneumatic brake circuit, wiring and conduit for mechanical defects. Repair or renew any parts found defective. (b) Test all control apparatus and electro-pneumatic brake apparatus with 35,000-ohm magneto, or 500 volts, for shorts and grounds. Repair all defects found. (c) Inspect all interlocks for worn or broken fingers and loose connections. (d) Try out sequence of switches and operation of electro-pneumatic brake; checking out for grounds with voltmeter at the same time.

Master Controller and Electro-Pneumatic Engineer's Brake Valve—(a) Remove covers and inspect for burned or broken fingers, rough drum, loose connections, etc. Operate controller to see that fingers have proper lift and clearance. Renew or repair as needed. (b) Test operation of control plug or cutout switch and push buttons. Repair or adjust if needed.

Edison Battery—(a) The electrolyte shall be adjusted to the proper level, using an Edison cell filler, by adding distilled water. (b) The voltage of the battery as a whole shall be read, the battery discharging for one minute at approximately normal rate. Individual cell readings shall also be taken. (c) Should the voltage of the battery as a whole average 1.2 volts per cell or less, the battery shall be fully charged. If any cell is materially lower than the average, action shall be taken to overcome the trouble.

Lead Batteries—(a) Check the voltage and specific gravity of each cell. If the voltage of the battery as a whole is lower than normal, or if the individual voltage or specific gravity of any cell is lower than the average, determine the cause and rectify it. (b) Fill all cells with distilled water to proper level. If the level of electrolyte in any cell is found materially lower than that of the average, determine the cause and rectify it. (c) Keep the terminals and connections clean and cover with vaseline to prevent corrosion.

Circuit Breaker Re-set Switch—(a) Inspect circuit breaker re-set switch. Dress or renew contacts if necessary. (b) Check operation of circuit breaker.

Relays—(a) Inspect and adjust if necessary, all relays, seeing that they function properly and are in good condition.

Comptroller Motor, Blower Motor and Motor Generator Set—(a) Inspect motors and motor generator set for electrical and mechanical condition. (b) Check bearing wear by use of feeder gage in air gap. (c) Clean commutator if necessary. (d) Inspect brushes and shunts, see that brushes fit properly to commutator and in brush holder. See that holders are not worn and that shunts are in good condition, that no copper is embedded in brush surfaces. Repair defects or renew brushes. (e) Lubricate bearings and see that oiling device is in good condition. (f) Make any other repairs necessary. (g) Blow out with compressed air.

Compressor Governor and Governor Switch—(a) Inspect contacts. Dress or renew if necessary. Examine shunts. (b) Clean switch piston insulator. (c) Test operation. Adjust for pressure desired, if necessary, or renew diaphragm.

Switchboard—(a) Clean panel. (b) Inspect switches. Dress or tighten contacts as may be necessary. (c) Inspect fuses. Renew defective ones. See that they are properly held by clips.

Headlights and Headlight Resistances—(a) Clean lens and reflector. (b) Renew lens if necessary. (c) Inspect connections and resistance, and test if necessary. (d) Test headlight.

Heater and Heater Wiring (During Heating Season Only)—(a) Inspect heater connections. Tighten if necessary. (b) Test heaters. Repair or renew defective parts.

All Auxiliary Apparatus and Circuits—(a) Test all auxiliary apparatus and circuits with 35,000-ohm magneto, or 1,000 volts, for shorts and grounds. Repair all defects found.

Fan and Intake Box—(a) Check fan for vibration and repair if necessary. (b) Open intake box. Remove air straining device if used, and replace with clean one, after blowing out box thoroughly with compressed air.

Miscellaneous Apparatus—(a) Inspect all apparatus not mentioned and place in good condition.

Blowing Out With Compressed Air—(a) After completion of inspection and repairs, all apparatus should be thoroughly blown out with dry compressed air, taking care not to use sufficient pressure to damage insulation.

6. At heavy inspection periods, in addition to the above work, the following shall be done:

Main Motors—(a) Test all parts with 1,000 volts

alternating current to ground for one minute. (b) Clean string bands and paint with insulating paint or varnish if needed.

Main Motor Wiring, Including Bus Jumpers—(a) Test all motors, motor circuit wiring, and connected apparatus, with 1,000 volts, alternating current to ground for one minute.

Circuit Breakers—(a) Clean and oil all moving parts. Clean and oil piston, renewing packing cup if needed. Remove valve magnet armature and valves, cleaning and repairing as needed. (b) Test breaker under load to see that it opens at proper current.

Reverser—(a) Clean and oil all moving parts. Clean and oil pistons, renewing packing cups if needed. Remove valve magnet armatures and valves, cleaning and repairing as needed.

Switch Group or Contactors—(a) Remove magnet valve armature and valves, clean and repair as needed. (b) Give interlocks and fingers special attention. (c) Replace leaking packing cups.

Pantagraphs and Connections—(a) Clean insulators of high voltage-pantagraphs and test with megger. (b) Test insulation of low voltage pantagraphs, with 1,000 volts alternating current to ground for one minute. (c) Clean and lubricate cylinders of high voltage pantagraphs every fifth inspection, and of low voltage pantagraphs every tenth inspection.

Third Rail Shoe Leads and Shoes—(a) Remove tape from terminals and examine for broken wires or defective soldering. Repair as needed and re-tape. (b) Clean and paint shoe beams with black asphaltum paint. (c) Test shoes and cables with 1,000 volts alternating current to ground for one minute.

Main and Regenerative Control Circuits and Electrical Connections to Air Brake Apparatus, Including Jumpers—(a) All control wiring and connected apparatus shall be tested for grounds and shorts with alternating current, as follows: Battery control equipment, 500 volts; line control equipment, 1,000 volts.

Control Jumpers—(a) At least once each year all train line jumpers to be removed from service cleaned and repaired. A current of 45 amperes for ½ minute shall be applied to all wires as a test for fractured cable strands and loose connections.

Edison Batteries—(a) Clean tops and outside of Edison cells with dry compressed air or dry steam. Coat top of cans with heavy vaseline and seats of valve caps lightly with Edison battery oil.

Lead Batteries—(a) Remove battery, and after filling each cell to proper level with distilled water, give the battery an overcharge at normal rate for at least one hour after the specific gravity for each cell has become constant. After this overcharge, adjust gravity in each cell.

Compressor and Blower Motor—(a) Test with 1,000 volts alternating current to ground for one minute.

Motor Generator Sets—(a) Remove motor generator, clean, repair and paint as found necessary, test windings by applying 800 volts alternating current for a period of 30 seconds on the alternating current end and 500 volts alternating current for a period of 30 seconds on the direct current end. (b) Replace on car or locomotive and check output on direct current end with ammeter and voltmeter.

All Auxiliary Apparatus and Circuits—(a) Test with 1,000 volts alternating current to ground for one minute.

7. At class repairs, in addition to the work done at regular and heavy inspections (except voltage tests) the following shall be done:

Main Motors—(a) Inspect motor shaft for wear, etc. Renew if necessary. (b) Remove armature, clean, dip in insulating paint and bake. (c) Renew band wires if necessary. (d) Turn commutators and undercut. (e) Inspect, clean and paint motor housing. (f) Clean, dip in insulating paint and bake motor fields. (g) Inspect armature and axle bearings. Renew or repair as may be necessary. (h) Inspect pinions for wear and defects. Renew if necessary. (i) Inspect gears and flexible drive for wear and defects. Renew any parts found unfit for service. (j) Inspect all bolts and suspension parts. Repair or renew as needed.

Main Motors and Main Motor Circuits—(a) Test insulation resistance with megger before and after voltage test. (b) Apply 1,500 volts alternating current momentarily and 1,000 volts for one minute. (c) Clean and paint all cables.

Main Transformers and Impedance Coils—(a) Remove from car, clean thoroughly. (b) Paint all connections. (c) Test windings with megger. (d) Replace on car.

Circuit Breaker—(a) Remove circuit breaker, clean, dip and bake coils. Place in good mechanical and electrical condition. Renew worn parts as needed.

Main and Regenerative Control Circuits and Apparatus—(a) Remove switch groups or contactors, master controllers, relays, etc. Entirely dismantle and overhaul. Adjust tension of fingers and clean interlock contacts. Adjust magnet valves, replacing parts as needed. Replace packing cups in all air cylinders and renew contact tips and arc chutes as needed. Repair worn parts of switches or contactors. Dip and bake contactor coils. In re-assembling, see that all parts are in adjustment. (b) Test control parts of battery control equipment with 500 volts to ground for one minute. Test control parts of line control equipment; and main current parts of all equipment, with 1,500 volts momentarily to ground, followed by 1,000 volts to ground for one minute. (c) Test insulation resistance with megger before and after voltage test.

Blower and Compressor Motors and Motor Generator Sets—(a) Remove and dismantle. (b) Clean, dip and make armatures and fields. (c) Clean and paint frames and leads. (d) Turn commutators and undercut if needed. (e) Renew band wires if needed. (f) Examine bearings and renew if worn. (g) Re-assemble and test with 1,500 volts alternating current momentarily to ground, followed by 1,000 volts alternating current to ground for one minute.

Other Apparatus and Circuits—(a) Dismantle, overhaul, and place in first class condition. Inspect wiring for chafed or broken places, loose terminals and defective taping. Repair or replace as needed.

Edison Batteries—(a) Clean tops and sides with dry steam to remove all foreign matter and loose paint. (b) Dip in suitable insulating paint to coat bottoms and sides of cans and crate, but not tops of cans. (c) Test for capacity. (d) Renew solution if needed. (e) Replace defective cells and fully charge battery.

Lead Batteries—(a) Remove the battery and dismantle entirely. Wash out sediment and clean plates. Straighten or replace buckled and worn plates, replace defective

separators, test jars for leakage, repair or replace weak crates, reassemble and fill with new electrolyte, overcharge for at least one hour and adjust gravity of electrolyte.

All Equipment—After assembling on locomotive or car, test all apparatus and connected wiring as follows: (a) Apparatus and wiring carrying power current, 1,500 volts alternating current to ground and between circuits momentarily followed by 1,000 volts alternating current to ground for one minute. Test with megger before and after voltage test. (b) Control apparatus and wiring on line control equipment, 1,500 volts alternating current to ground momentarily followed by 1,000 volts alternating current to ground for one minute. In addition, test between all circuits with 1,000 volts alternating current momentarily. Test with megger before and after voltage tests. (c) Control apparatus on battery control equipment, 500 volts to ground for one minute. In addition, test between all circuits with 500 volts momentarily. Test with megger before and after voltage tests.

The members of the committee are: G. C. Bishop (Chairman), Long Island; W. L. Bean, N. Y., N. H. & H.; J. H. Davis, Electrical Engineer, B. & O.; J. V. B. Duer, Pennsylvania; A. Kearney, Superintendent Motive Power, N. & W.; C. H. Quereau, N. Y. C., and L. K. Sillcox, C., M. & St. P.

Discussion

J. H. Davis (B. & O.): I did not come prepared to present this paper, thinking that Mr. Bishop, the chairman, would do so. There has been no meeting of the committee, and Mr. Bishop prepared the information and submitted it to the committee members.

There has been some criticism relative to recommending these rules, or submitting them as recommended. No provision has been made for the daily inspection of electrical equipment for either locomotives or multiple unit cars. I believe it would be well for the committee to consider a revision of the paper and provide for further inspections.

In general these specifications or instructions are applicable to any class of equipment. Reference is made to the third-rail shoe and other fuses. I believe the committee will want to modify that a little. What we are really trying to cover is fuses as well as third-rail shoes.

I believe that this paper, when finally prepared and put into a little better shape, will be a valuable one for the member companies having to do with the operation and maintenance of electrical locomotives and multiple cars and I hope there may be some discussion in order that the committee in making any revision may have before it all the information possible.

Chairman Coleman: The committee would like to review this paper, possibly, for another year. It is now before you for discussion and a motion would be in order to accept the paper to be printed in the proceedings and the committee continued for further investigation to prepare a full report next year.

Mr. Giles: I move that the paper be accepted and printed in the proceedings and the committee continued.

Mr. Oviatt: It will be noted that the committee has specified certain mileages and still leaves it optional with the operating officials to determine the extension of that mileage before the inspection is made. From my knowledge of this class of equipment one of the most important things is an inspection based upon definite mileage; in other words, to find out your troubles before they really happen. This refers to mighty important electrical equipment and I would second the motion that the committee be continued and this paper brought before the convention next year with not only definite recommendations as to the mileage, but more complete material in line with the suggestions as to inspection, maintenance and so forth.

Questions Wisdom of Proposed Instructions

L. K. Sillcox (C. M. & St. P.): In general, a uniform set of instructions for the maintenance of electrical equipment of rolling stock is, at least under the present conditions, neither feasible nor desirable. Such rules or instructions must have as their purpose either one or both of the following objects: 1. The standardization of maintenance practice. 2. To serve as a guide for a set of instructions to those roads which are in a position to need such assistance.

With the first object in mind, I believe that the tendency to comprehend under uniform rules complex and often dissimilar equipment operating under dissimilar conditions and which particularly as regards locomotives, is not and, in the present state of the art, cannot be standard, is to be deplored. I am heartily in accord with the standardization, not only on paper but actually in practice, of those things which in their use and application are universal enough and similar enough to make their standardization profitable, but do not believe that the proposed attempt comes into this class. The resulting rules can, at best, be but a compromise and actual practice will vary just the same.

A competent management will adhere to a program based upon its own experience or the expert experience of those familiar with the problem. If the proposed rules are intended for the guidance of those contemplating electrification, their value will be questionable as, owing to the fact that certain items cover certain types only, it will not be known which are applicable and which are not, without the advice or under the direction of those having experience, in which case the rules would be unnecessary. In any event, the maintenance work will actually have to be done by men who are experienced in such work, and to them many of the detail instructions, covering operations required and involved in maintenance, will appear superfluous and unnecessary.

The most feasible and profitable way for any road to handle the standardization of maintenance, either of methods at one shop or as regards uniformity at the different shops of the road, is through meetings at which are represented those who are connected with the operation and therefore in the best position to determine the questions involved and keep the situation lined up to the requirements as they develop. This might be supplemented by occasional interchange visits of proper supervisors of the different roads, so that proper improvements in methods or practice developed in a particular case may, if applicable, be mutually taken advantage of.

It will be seen from the above that I question the soundness of the principle of the proposed instructions, feeling that the latter cannot be laid down with the specificness attempted, for the equipment and conditions varying so widely, and still possess the value which A. R. A. rules, etc., should possess.

Suggests an Alternative Course

If the urge for the standardization of maintenance, under such dissimilar conditions, cannot be resisted, the following alternative course might be considered:

Agree to what is meant by the terms "regular inspection," "heavy inspections," "class repairs," etc., as applied to electrical equipment and as is undertaken in your pamphlet, "Steam and Electric Locomotive Repairs," June, 1921; develop the character of the work usually covered under each term and, if desired, supplement this with a statement by each road covering, in general, the character of equipment it maintains, and its usual maintenance practices.

The proposed instructions, outside of the length of periods, are fairly comprehensive for 750-V. direct current locomotives or multiple-unit equipment and the low-voltage and the high-voltage alternating current locomotives and multiple-unit equipments, but do not fairly comprehend the high-voltage direct current locomotives or multiple-unit equipments or the high-voltage end of alternating current locomotives. If these could be eliminated, then the objections might be less.

Disregarding the views, as expressed above, the following general comments are made on the rules as they stand:

Comments on Proposed Rules

Introduction. The wording of the first sentence does not make clear, it seems to me, what the purpose of the instructions may be. Are they considered as the result of investigation of the practices existing on different railroads to represent the best practice, and is it the intention that the different roads joining in the investigation are in the future to be governed by them? Or, are the rules gotten up merely for the guidance of those roads which do not have an organization suitably experienced to evolve their own set of rules? The instructions are stated to be based "on the experience and actual practice of those roads having electrically equipped rolling stock." What roads, then, are the "other" roads referred to?

I think that the wording of the first sentence is misleading, as in many cases, at least as far as our railway is concerned, practice deviates from that indicated by the suggested rules more than the use of the modifying words "based" and "general" justify.

I think it might be inferred from the third sentence in the introduction that the roads participating in the preparation of the instructions have agreed to adopt them as general practice with but minor modifications, whereas I think it will be found where the best maintenance obtains, that the modification "to suit location conditions" will govern, rather than the practice outlined. I presume "to suit local conditions" comprehends differences in policy with respect to standard of maintenance, etc.

The last sentence might be considered as implying that no additions to the instructions would be necessary except those required to insure safety to the workmen. This, we are sure, cannot be intended. The additional detailed instructions which must be issued adequately to cover the type of equipment used on a particular railroad would comprise a very appreciable addition to the general rules.

Article 1: This is not quite clear. Does it mean that all the rules do not apply to all classes of equipment and only the rules that fit a particular class of equipment are to be deemed applicable?

Article 2: Inasmuch as it is left to each road, and properly should be if the most economical and satisfactory results are to be obtained, to determine the suitable mileage figure, I do not quite see the desirability of giving a fixed figure. Moreover, there may be in individual cases, other bases which would determine the inspection period, rather than the mileage basis; for instance, particularly in the class of multiple-unit systems. Here the practice of inspecting after the use of a certain number of kilowatt-hours is looked upon with favor. I do not mean to intimate that this would be a desirable basis in all cases, but to emphasize the point that circumstances alter cases.

As only two classes of inspection are covered (the current inspection given a locomotive when it reaches a terminus and goes into the engine house apparently being disregarded), the inference would be that usually there is no other inspection given or required. I presume this is not the intention.

Article 3: I consider the periods given as too arbitrary; they should at least be modified by some such additional wording as, "or as many as operating experience may indicate to be best and most economical."

Article 4: General remarks above apply. The use of the word "shall" in the instructions indicates compulsion and we believe is out of place; but particularly objectionable with respect to Article 4. The reason a railway makes classified repairs at a certain time, or after a certain period of mileage, or after something else, is because it needs to, the necessity being determined as indicated by an unusual number of failures, or by observation of general conditions, or by past experience either with the equipment or similar equipment in a given service, and not because it happens to be a rule which has been agreed upon.

With respect to "Class Repairs," we are not clear as to how the use of this term corresponds to its use in your pamphlet of June, 1921, in which the class of repairs is based essentially on the character of the work necessary, rather than on mileage, the latter being referred to merely as an expectancy.

Regular Inspection, Heavy Inspection and Class Repairs

Testing Insulation. Under regular inspection, main motors, etc., it is stated, "Test insulation resistance with 35,000 ohm magneto, or with 1,000 V. to ground for one minute, for short circuits and grounds." What might be intended is first roughly to test the insulation resistance by 35,000 ohm magneto to ground or between isolated circuits, or to test the di-electric strength of insulation to ground or between circuits. If no di-electric test is intended by the use of 1,000 V. (a. c. or d. c. not specified), then a voltmeter, or megger, would of course be implied, unless only an indication of a complete breakdown is wanted. If no di-electric test is wanted, then a time interval is of no value. If di-electric test is wanted, then the voltage, to do any good, would depend upon the character of the insulation and the voltage for which it is designed. Incidentally, under heavy inspection, a. c. voltage is specified.

Regular Inspection, Main Motor and Motor Wiring, etc. If it is intended to apply proper a. c. voltage for one minute to interconnected d. c. machines, certain voltages detrimental to the insulation may be set up if the current is taken from transformers, etc., having a steep wave

front and if the inductance and capacity of the circuits bear certain relations.

The clarifying of the intention, as above, of the use of suitable high potential, instead of 1,000-Volt a. c. or dielectric test, and the cautioning against the improper use of a. c. voltage for interconnected d. c. circuits is recommended.

General: R. I. (Regular Inspection) and H. I. (Heavy Inspection). In some cases only inspection is called and no rectification. Should not a uniform form be adhered to?

R. I. and H. I. In some cases inspection is called for under a sub-letter and then the following subs cover detail which is really comprehended by the general term of the preceding sub referred to.

R. I. and H. I.—Pantagraph. Why differentiate between the inspections, adjustments, cleaning, etc. (except insulators), between high and low voltage, between a. c. and d. c.? What is high voltage? What is low voltage? What about lubrication of pantagraph shoes?

R. I. Fuses. What about inspection as to proper size as well as proper number of fuses?

R. I.—Lightning Arresters. What about height and condition of electrolyte? What about removal of lightning arresters in winter?

H. I.—M. G. Sets. Why remove M. G. sets? Why check output?

C. R.—Main Motors. Is it necessary or desirable to take out field coils? Is it necessary or desirable to turn and under-cut commutators? We have many that have never been turned.

C. R.—Circuit Breakers. Is it necessary or desirable, particularly in the case of low voltage control, to remove coils and re-insulate unless necessity is indicated by test or otherwise?

C. R.—Main and Regenerative Control Circuits and Apparatus. Is it necessary to remove and dismantle contactors, etc?

C. R.—Compressor Motors and M. G. Sets. Is it necessary or desirable to remove field coils?

(*The question was then called for, put and carried.*)

Report on Locomotive and Car Lighting

The following subjects have been considered by the committee during the year: Locomotive headlight lamps, locomotive cab lamps, axle generator pulley bushings, axle generator belt drive, and car lamps.

Locomotive Headlight Lamps

The committee has kept in touch with lamp improvements that have been developed during the year. The suggestion has been made to the lamp manufacturers that it would be very desirable to obtain a definite mechanical difference in the headlight lamps for the primary purpose of identification. A possible change from the present G type of bulb to the PS type of bulb is reported. This will likely permit maintaining a separate sized bulb for each size of lamp required and will also permit of improved focusing of the light.

Locomotive Cab Lamps

The 15-watt, 33-volt S-17 lamp now in general use for locomotive cab lighting in gage lamps, etc., has been reported by some member lines as unnecessarily large and a smaller lamp has been called for. A 15-watt, 33-volt S-14 lamp is available and the committee requests that member lines try out the new lamp during the coming year and give the committee a record of the service obtained.

Axle Generator Pulley Bushings

The association has a standard practice that leaves to the user the determination of the actual length of the bushing and its internal diameters, the latter being dependent upon the size of axle and position on the axle at which it is used.

The corrugated steel type of split bushing is today most widely used for this purpose. Due to the lack of established dimensions for these bushings an investigation has developed that a very large number of sizes are in use. For the 5-in. by 9-in. axle alone, over 12 sizes of bushings have been found which are used to a considerable extent. From a study of this subject it has been found that two sizes of bushings for each size of axle will take care of practically all pulley positions in general use today. In this study consideration has been given only to bushings for application to the taper section of the axles. The internal diameters shown for the bushings are based on the assumption that the axles are turned to the actual dimensions given as A. R. A. standard. The lengths for the bushings have been selected to permit using the same bushing either with or without bushing clamp. A long bushing is also desirable, as it provides for a greater range for shifting the bushing along the axle to correct for variations in the actual diameters of the axles along the section where the bushing is applied. Different lengths for the two bushings for the same size axle have been selected to facilitate ready identification due to the small differences in the internal diameters for these two bushings.

The proposed dimensions for axle pulley bushings are given in the table.

TABLE I—AXLE PULLEY BUSHING DIMENSIONS

A. R. A. axle journal in.	Bushing designation	Location of center line of bushing from center line of axle, in.	Bushing dimensions, in.			
				Diameters		
				Inside		
			Length	Large end	Small end	Outside
4¼ by 8	B-1	13	13	5 11/32	4 29/32	7½
	B-2	7½	12	5⅛	4¾	7½
5 by 9	C-1	13	13	6 1/16	5 9/16	7½
	C-2	7½	12	5⅞	5⅜	7½
5½ by 10	D-1	13	13	6⅝	6 1/32	7½
	D-2	9	12	6 13/32	5⅞	7½
6 by 11	E-1	12	13	7 3/32	6 17/32	7½
	E-2	9	12	6 31/32	6 7/16	7½

With the type of axle pulley in general use having a hub 6¼ in. long and using a bushing without clamps, the range of pulley locations possible for the above bushings when the latter are placed on the axle at locations designated in Table I is shown in Table II.

For axle generator drives where it is desired to have the center line of the belt coincide with the center line of the car it is necessary either to use wide face axle pulleys having two separate hubs or else employing bushings of special design if single hub pulleys are used.

The committee suggests the adopting by letter ballot as recommended practice, the axle pulley bushing and the range of pulley location on the axle as indicated in Tables I and II.

Axle Generator Belt Drive

In view of the importance of the subject of the drive for axle generators your committee has considered it desirable to report on new developments or improvements

that are of general interest. During the past year there has been developed the so-called wide face axle pulley, two general designs having thus far been brought out. One design is known as the barrel type of pulley and as first developed was 18½ in. in diameter, 33½ in. over all, having a 1-in. flange. In the later design the length has been decreased to 28½ in. This design of pulley has been used entirely with free speed type of generators with the belt located along the center line of the car. There are at present about 450 of these pulleys in service.

Table II—Range of Pulley Locations

Bushing designation	Location of center line of pulley from center line of axle, in. Max.	Min.
B-1	16⅜	9⅝
B-2	10⅜	4⅝
C-1	16⅜	9⅝
C-2	10⅜	4⅝
D-1	16⅜	9⅝
D-2	11⅞	6⅛
E-1	15⅜	8⅝
E-2	11⅞	6⅛

The other design is 18 in. diameter, 24 in. straight face with 2-in. flaring flange. This pulley has so far been used only with the controlled speed type of axle generator, the belt being located approximately 5 in. from the center of the car. Approximately 100 of these pulleys are in service on one railroad and 50 on another.

These types of pulleys have not yet been in service long enough to permit accumulating sufficient data for a reliable comparison or belt performance with standard pulleys. It has been definitely established, though, that they will prevent belts from running off the pulleys with body hung generators where cars are operated over extremely short radius curves, under which conditions the majority of standard drives for body hung generators will frequently throw off the belts.

There has also been developed and is being tried out in service a universal axle pulley of such construction that it will rotate in a vertical plane so that the pulley remains in line with the belt when the car is running on curves. The pulley was put in service May, 1922, using a 4-in. 5-ply rubber belt with special flexible belt fastener which was reported as still in service on June 1, 1923.

Car Lamps

There is an increased use of the 25-watt 30-34-volt gas filled lamp which the manufacturers are furnishing in the PS-16 type and size and which a member road recommended to be of the PS-18 type and size. It has been suggested that this lamp and the 100-watt, 30-34-volt, PS-25, C lamp be added to the list of recommended sizes for train lighting. The committee believes that in anticipation of a rather radical change in the dimensions and type of bulb used in train lighting it is not advisable to do so at this time.

The members of the committee are W. E. Dunham, chairman, C. & N.; W. H. Flynn, superintendent motive power, M. C.; E. W. Jansen, I. C.; J. L. Minick, Pennsylvania; J. J. Tatum, superintendent car department, B. & O., and E. Wanamaker, C. R. I. & P.

Discussion

W. E. Dunham (C. & N. W.): The committee is looking into the matter of a proper dimensioning of the glass reflectors for headlights. There seems to be a difference of opinion among manufacturers. In giving the figures for his reflector one manufacturer will use the inside depth of the reflector and the inside diameter at the large end; whereas other manufacturers will use the outside dimensions, and this is rather confusing. That particular feature is being checked over and we anticipate having a report on that subject next year.

E. B. Katte (N. Y. C.): May I direct your attention to what appeared to be an omission on the part of the committee, that might save some money to some of the member companies. While there are some radical changes to be made in car lighting lamps within the next year or so, I do not know of any specific change which will affect the PS-18 lamp. This is a large lamp, gives a little better diffusion and a considerably better appearance, in the existing lamp shade, and it will make a difference in the price, I am told, of some three to four cents a lamp. On one road that might make a saving during the coming year of $4,000 or $5,000 in the purchase of lamps. We would appreciate it if your committee, or if this convention might add this lamp as one of the approved lamps at this time.

(*A motion that the report be accepted and submitted to letter ballot was then made, seconded and carried.*)

Railroad Solves Hotel Problem

The week from June 2 to 9 saw the largest body of Shriners ever assembled. The occasion was the Imperial Council Session in Washington, D. C., where over 300,000 members of the Mystic Shrine assembled from all over the United States to take part in the Council. Great preparations were made by the city to entertain and take care of the visitors and the streets were a mass of decorations, especially the famous Pennsylvania Avenue, where elaborate electric decorations had been made.

Auxiliary Battery Charging Equipment in Service

One of the great problems was the accommodation of so many visitors, and the Pennsylvania Railroad relieved the situation in a unique way.

Nearly four hundred Pullman cars were used in the several yards of the Pennsylvania Railroad as hotels, accommodating 10,000 delegates, and in order to keep the Pullman storage batteries charged to furnish light and power for the electric fans, 130 Farmelectric lighting plants, with a capacity of 1½ kw., were installed between the tracks on skids, each machine charging three cars at once.

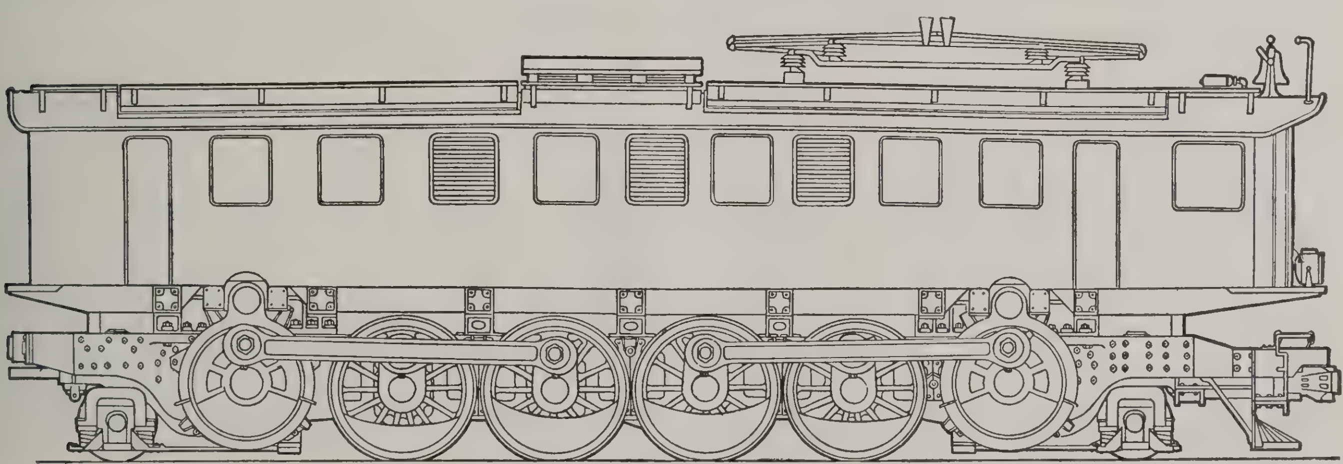
A Heavy Coal Train on the Virginian West of Rock, W. Va.

Locomotives for the Virginian Electrification

Will Handle 6,000 Tons Over Mountains and 9,000 Tons on Down Grade—Construction Details

By R. L. McClellan
Westinghouse Electric & Manufacturing Company

THE electrification of the Virginian Railway, which was dealt with briefly in an article which appeared in the *Railway Electrical Engineer* of May, page 131, embraces 134 route miles (213 miles of track) between Mullens, W. Va., and Roanoke, Va., and includes the district most difficult of operation because of the severe grades met with by the road's heavy coal trains in crossing the Allegheny mountains. It represents one of the most important single undertakings entered upon by any railroad since the war and is said to represent the largest single contract for railroad electrification ever awarded. The project provides for handling all freight electrically, involves the construction of a large steam generating station, transmission lines, an overhead trolley system and a number of electric locomotives, and makes provision for material increase over present traffic capacity. The undertaking involves an expenditure of $15,000,000. The contract for all equipment has been awarded to the Westinghouse Electric & Manufacturing Company and the alternating-current single-phase system is to be used.



Type of Motive Power Unit Being Built for the Virginan

The Virginian Railway, built by the late H. H. Rogers, extends from Deep Water, West Virginia, through the rich Pocahontas and New River coal fields to tidewater at Norfolk. It is preeminently a coal road with a heavy eastbound traffic. The railway has long been recognized as a leader in the movement of heavy tonnage and in the operation of exceptionally heavy trains and the use of the largest of steam locomotives. The Virginian first became con-

spicuous for what was then referred to as its extravagant policy of designing, building and equipping for the movement of tonnage materially in excess of what then appeared to be reasonable expectations. "Roger's folly," as it was then called, has, however, since been vindicated. The Virginian has, in late years, been conspicuous for its 120-ton coal cars, the use of the most powerful Mallet locomotives, the operation of 8,000-ton trains and the development of a coal pier at tidewater of remarkable proportions, and is now establishing a new claim for leadership in undertaking electrification.

The principal objects of this undertaking are two: First, the expansion of its traffic handling capacity; and, second, the improvement of operating efficiency or reduction in ton-mile costs.

The Virginian is now moving, from Mullens, W. Va., to Norfolk, Va., about 7,000,000 tons of coal per annum. This movement is made in trains of approximately 5,500 tons up the west slope of the mountains at a train speed of about 7 miles an hour and thence down the east slope of the mountains and to tidewater in trains of 6,000 tons. With electric operation trains of 6,000 tons will be moved up the west slope of the mountains at 14 miles an hour and will be filled out there to 9,000 tons for movement to tidewater. The initial operation will be laid out for an annual movement of 8,000,000 net tons of coal and the system will be designed to have a capacity for handling more than twice this amount. The higher train speeds, the uniformity of speeds and the greater amount of power which can be applied to an individual train will enable the movement of more than twice the present tonnage.

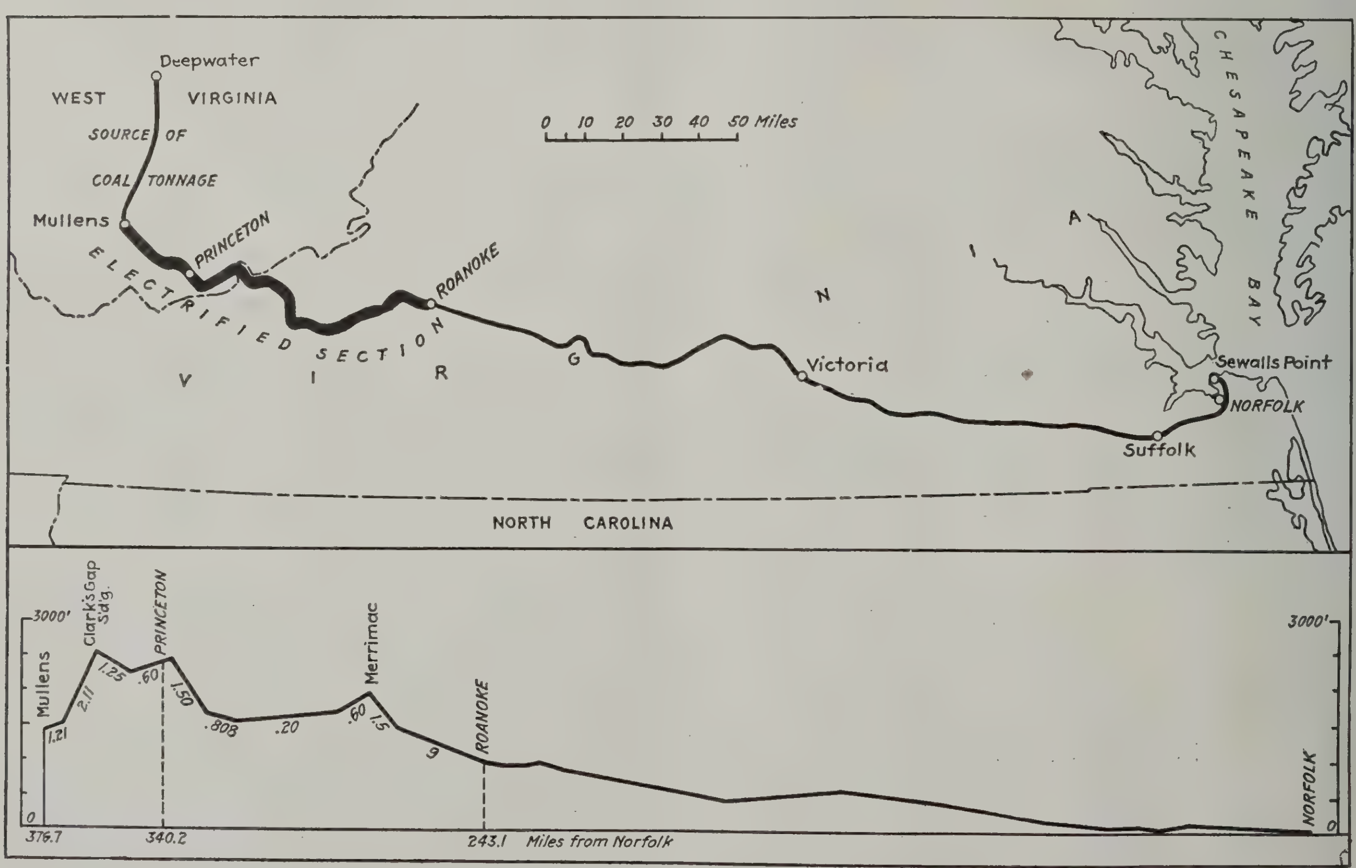
The expectation of the management is that the electric locomotives will be available for service during a greater portion of the time than the present steam equipment, that the cost of maintenance for electric locomotives should be less than for steam and that the production of power in a stationary power plant should be more efficient than in the steam locomotive, in this way bringing material economies.

The system adopted is the alternating-current, single-

A 270-Ton Electric Locomotive with Heavy Coal Train on the N. & W.

phase system with an overhead trolley, similar to that in use on the Norfolk & Western, the New York, New Haven & Hartford, the Pennsylvania at Philadelphia, the Grand Trunk, the Boston & Maine and the Erie.

Each locomotive will have the following characteristics:



Map and Profile of the Virginian Showing Section to Be Electrified

Total weight, approx.	600 tons
Weight on drivers	450 tons
Tractive effort, continuous	135,000 lb.
Tractive effort, maximum	277,500 lb.
Speed	14 or 28 m.p.h.
Horsepower continuous at 14 m.p.h.	5,115 hp.
Horsepower continuous at 28 m.p.h.	5,970 hp.
Diameter of drivers	62 in.
Length over coupler knuckles	145 ft. 8 in.

The locomotive will receive current from an 11,000-volt trolley wire through pantagraph collectors; this current will be stepped down by transformers in the locomotive cabs to a low voltage and delivered to the phase converters which will convert this single-phase to three-phase current for use in the main motors. The main motors, six in number, will be of the induction type with wound rotors, controlled by liquid rheostats in the secondary circuits. Induction motors are used with a view of providing ruggedness and simplicity of construction and a dependability of operation which characterize this type of motor and does away with the use of commutators.

Power is transmitted through gears and pinions to jack shafts which are connected to the drive wheels by side rods. There are six such motors and six jack shafts per locomotive, each connected to two driving axles. This design enables mounting the motors above the locomotive frame, and the use of side rods makes possible the use of the entire weight on drivers for adhesion, making possible a tractive effort in excess of that possible with individually driven axles.

A feature of the system adopted is its unusual capacity for regenerative braking. It has long been recognized that in such an operation as that of the Virginian one of the most serious problems is controlling trains while descending steep grades. This will be accomplished in this case entirely by regenerative braking, the air brakes being held entirely in reserve for emergency use. With the type of motor and the system adopted the full capacity of the locomotives is available for holding on down grades and this permits holding a heavier load descending a grade than can be handled up the same grade.

A steam power station with an installed generator capacity of 50,000 kw. will be built at a convenient location on the New River near the middle of the section to be electrified. Single-phase current will be transmitted at 88,000 volts over twin circuits on steel towers. The voltage will be reduced by means of transformers located at intervals along the right-of-way to 11,000 volts for the use on the trolley. The trolley system will be the inclined catenary type utilizing a bronze contact wire and steel messengers all supported on steel poles and structures. No substations with revolving machinery are required for the system adopted for the reason that the locomotives utilize the same kind of current as is generated in the power station, i.e., alternating-current single-phase. The power is fed to the trolley by simple out-door type transformer stations.

The Heavy Type of Mallet Now Used to Handle Virginian Coal Trains

Unique Dumping Scheme Planned in New Coal Pier

A new electrically operated coal pier with a unique dumping scheme will be erected by the Virginian Railways Company at Sewell's Point, Norfolk, Va. The operating machinery will be furnished by the Alliance Machine Company, of Alliance, O., and the contract for the major portion of the electrical equipment has been awarded to the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

In the dumping operation planned for the new coal pier, the loaded railroad cars will be hauled up an incline into the dumping position by a hoisting machine with a cable connected, small narrow gauge car, known as the mule, running between the standard gauge railroad tracks. The car dumpers will then turn the cars over, permitting the coal to fall into containers, called elevating pans. As the empty cars are returned by the dumpers, the loaded elevating pans, acting as counterweights for the cars, will be raised to the top of the pier. These pans, raised to the top of the pier, will then deliver coal to motor-driven cars, known as transfer cars, which, running along the top of the pier, will deliver the coal to the boats through loading towers.

This installation will be unique in that neither the railroad cars nor the transfer cars will be hoisted to the top of the pier. The handling scheme planned eliminates the necessity of elevating the transfer cars without resorting to the heavy and expensive construction required when the road cars are hoisted in the dumping operation.

The electrical equipment for the car dumpers includes four 325 hp. motors for hauling the railroad cars into the dumping position; four 450 hp. motors for dumping the cars and a number of smaller mill type motors for the auxiliary motions. Each of the transfer cars will be equipped with four 40 hp. motors with series parallel control.

Courtesy that is all on one side cannot last long.

To get ahead, you must get a head.

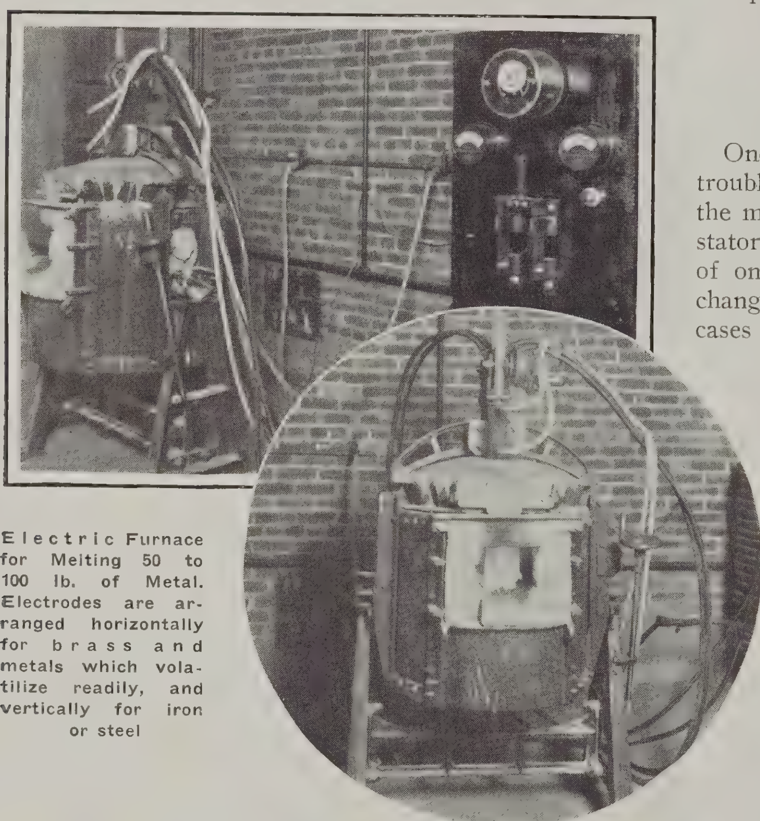
Do a little more than is expected of you.

We grow by doing.

Small Electric Furnace

Electric furnaces for a variety of purposes such as melting, annealing, baking, drying, etc. are beginning to find a place in railroad shops. The Booth Electric Furnace Company has developed a small electric furnace to meet the demand for a furnace that will melt from 50 to 100 lb. of brass, copper, iron or steel.

The furnace is so designed that the electrodes are in a vertical position, when brass or other metals which volatilize readily are to be melted, and in a horizontal position for melting iron and steel. It is mounted on trunnions so that the charging door and pouring spout may easily be brought to the proper height for charging and pouring. The furnace is tilted for pouring by turning a hand wheel. No foundation is required.



Electric Furnace for Melting 50 to 100 lb. of Metal. Electrodes are arranged horizontally for brass and metals which volatilize readily, and vertically for iron or steel

The electrodes used are 2 in. in diameter and are made of Acheson graphite. They are water cooled and are provided with nipple joints for continuous feeding. The lining of the furnace may be either basic or acid for melting iron or steel. If both steel and brass are to be melted, an extra furnace shell and lining are furnished to prevent contamination of the brass from the steel. Something in excess of a ton of steel can be melted in a day with a single furnace.

The furnace is supplied complete with 800 amp. reactance coil, circuit breaker, current transformer, voltmeter, ammeter, slate switchboard, water hose, wall fittings and one acid lining. An autotransformer can be supplied for operating the furnace from a 220-volt circuit if 110-volt power is not available.

Why the Bearings Ran Hot

By A. Foreman

One of the motors in the machine shop had been giving trouble because of the fact that metal chips dropped into the motor and wedged themselves between the rotor and stator, causing grounds and, in one case, the burning out of one of the stator coils. As it was not practical to change the location of the motor, as is usually done in cases of this kind, it was decided to install enclosing shields on the inside of the endbells, thus making it a totally enclosed motor. Of course this would cause the motor to run considerably hotter, but the motor was somewhat larger than was necessary for the job, so we deemed it safe in that respect.

After installing the shields the motor developed a hot bearing within three days. A machinist installed a new bearing and it lasted about the same length of time. I was called in at this time and made the usual tests for defects, such as too much belt tension, loose oil plugs, etc., but found everything to be all right except that the oil was low in the wells, and when I removed the endbells and rotor the winding was seen to be saturated with oil. This would usually have been occasioned by worn bearings or defective oil throwers, but the oil collars seemed to be in good shape and we knew that the bearings had been good, so we had to look further.

Whenever I run into a job that stumps me I find a nice quiet, comfortable place where I can sit down and reason the matter out, so I made an excuse to get away for a minute or two. I walked over to a string of day-coaches that were lying on a nearby track and proceeded to concentrate on the matter at hand. How did the oil get past the collar which, as mentioned above, appeared to be in good shape? Centrifugal force throws such oil as comes in contact with it, against the inside wall of the bearing

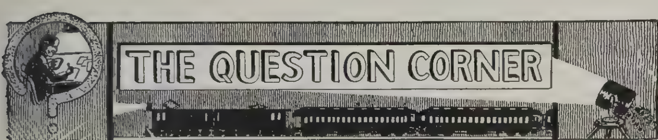
housing, where it returns to the bottom of the well to be brought up again by the oil ring, so that if oil passed these collars it must do so by virture of some force stronger than centrifugal. What could this force be—suddenly it occurred to me—suction.

On further investigation of the motor I found that there were some lateral openings in the motor frame on the under side, and I decided that this must be the outlet for the air current which, according to my reasoning, must pass through the oil wells due to the fan action of the revolving rotor. Forthwith I installed tight-fitting felt gaskets on the oil well housings and time has proven that my solution of the difficulty was correct.

Defeat is often a spur to victory.

The best reward is sense of worthy achievement.

A liar is sooner caught than a cripple.



Answers to Questions

1. *What are the principal causes for excessive growth of battery plates?—M. M.*

2. *I should like to have someone give a good method for testing polarity of poles on a car lighting generator after coils have been changed.—C. J. D.*

Excessive Growth of Battery Plates

1. The lead battery plates of the Planté type frequently grow excessively in car lighting service. It will be found that the growth almost always occurs in the positive group. The reason for this is because an abnormal amount of active material is formed and this material, which is lead sulphate and lead peroxide in a more or less spongy state, takes up considerably more space than did the original lead plate from which the sulphate and peroxide were formed. The space between the ribs of the plate fills with still more active material and the plate expands to accommodate the new material formed.

When a battery is operated normally, a gradual formation of reserve lead in the positive plate takes place. This occurs at about the same rate as the shedding of the active material from the outer surfaces of the plate so that the total capacity of the battery is kept about constant and the plates are not stretched by an oversupply of active material.

Certain chemicals frequently found in electrolite as impurities cause excessive formation of active material in the positive plate and the cause of abnormal growth in plates may be attributed to these impurities. However, low rate charging will cause this though there be no impurities present. One of the more common impurities is a certain amount of forming agent used in the original manufacture of the plates which is not removed in the process of manufacture.

The forming agents employed in battery manufacture are either the nitrate, acetate, chlorate or perchlorate of lead; all of these are soluble forms of lead. Some of these forming agents are more stable than others; nitric and acetic acid are decomposed by battery action and will be ultimately almost eliminated as an impurity in the battery. Perchloric remains and traces of the others. When these agents remain in such quantities as to form a large percentage of the reserve lead in the plate before they are finally decomposed by the current action, trouble occurs.

Nearly every kind of wood contains certain substances which in coming in contact with sulphuric acid form acids such as acetic acid, formic acid and tannic acid, these being known collectively as wood acid. All of these acids may act as forming agents if found as impurities in battery electrolite.

Wood battery separators are treated chemically to remove dangerous amounts of wood acid before being used as separators in the battery. It is contended by some that a small amount of wood acid may have a beneficial action in the battery but it is usually considered injurious and should be avoided whenever possible.

* * *

Testing Polarity of Poles

2. In putting in a new set of field coils, the coils should always be tested for polarity. If one coil of a 4-pole generator is reversed, it will greatly unbalance the generator and prevent its working properly. After field coils have been connected up but before the armature is inserted, pass a small current through the field coils by connecting to battery or other d. c. circuit. If a compass is handy place it near the face of each pole and the north pole of the compass will be attracted to each south pole of the generator and the south pole of the compass to each north pole of the generator.

In the event a compass is not available, magnetize a needle by rubbing it upon one of the poles of the generator and then suspend it from its center by a piece of thread about eight or ten inches long so that the needle is free to turn when hung near the poles of the machine.

If the fields are connected properly, the needle will turn its point to two of the poles and its eye toward two of them. If it turns the eye to three of them and the point to only one, or the point to three and the eye to only one, the field coil on the middle pole of the three should be reversed.

* * *

Questions for July

Here are a number of problems regarding car lighting lamps which I should like to see answered fully in the question corner of the Railway Electrical Engineer.

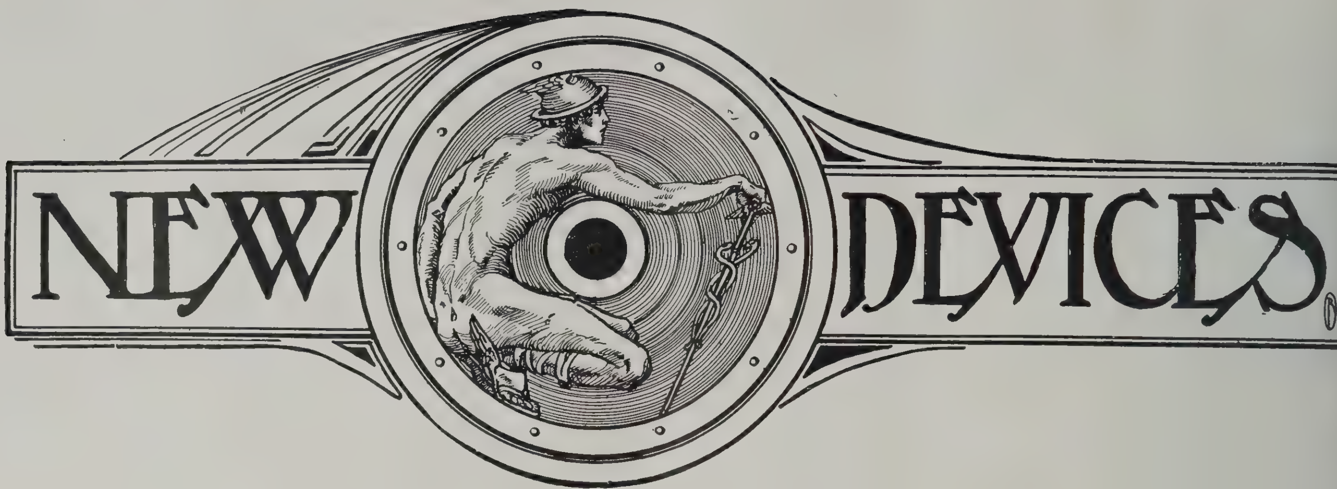
1. *How much current does a 60-volt, 25-watt lamp require when operated on a 60-volt circuit?*

2. *How much current does a 30-volt, 25-watt lamp require operated on a 30-volt circuit?*

3. *What is the resistance of a 25-watt, 30-volt car lighting lamp and of a 25-watt, 60-volt car lighting lamp?*

4. *What current will flow through 60-volt car lighting lamp when connected across a 30-volt axle generator as a pilot lamp?*

5. *Suppose a 30-volt, 25-volt watt lamp and 50-volt, 25-watt lamp are connected in a series across a 60-volt circuit, how much current will flow and what is the total resistance?—P. H.*



Safe and Efficient Blow Torch

The Master blow torch, illustrated, is now being marketed by the Turner Brass Works, Sycamore, Ill., and embodies a number of novel and useful features. A safety valve, located at the end of the horizontal pump cylinder, is fitted with a diaphragm accurately proportioned to give away automatically at 40 lb. air pressure. As torches operate at 18 to 20 lb. pressure, this valve will not come into action until about double the normal pressure is present. A thumb-nut on this valve permits the operator to release the air pressure after his work is done, or to decrease the pressure as desired during the operation of the torch.

Another valuable feature is the fact that there is but one opening in the tank. This opening is at the top, above the fuel line, and is sealed by the screw thread filler-plug. By eliminating such soldered connections as burner inlet and upper and lower pump brackets, a frequent cause of leakage trouble is removed.

The pump is equipped with a pump leather that spreads like a parachute on the work-stroke and closes on the return stroke. This leather is automatically lubricated from a reservoir of vaseline in the brass washer at the end of the pump rod.

The fuel, in its journey from the tank to the combustion chamber, passes through the interior of a solid bronze baffle in the head, called the "Hot Spot Hump." This baffle is located near the outlet of the burner tube in the path of the flame. It very soon becomes white hot, the intense heat vaporizing the fuel into a hot, dry, highly-inflammable gas. Kerosene or the leanest grade of gasoline can thus be burned.

Efficient combustion means not merely the total consumption of the fuel without unburned residue, but also the maximum admixture and combustion of oxygen from the air. Instead of depending upon a multitude of holes in the burner-tube for oxygenation of the fuel, the Turner Master torch admits air through a flared inlet in front of the needle valve. This inlet is a bell-shaped nut, turned from brass screw stock and threaded so that the operator with thumb and finger can screw it into or out of tube, thus regulating the distance from the needle-valve, and consequently, the volume of air admitted.

Air is also admitted through a long slot at the top of the burner tube, immediately above the "Hot Spot Hump," previously referred to. This supplementary air inlet performs two functions; it deflects the flame downward upon the baffle or "Hump," and it provides additional oxygen to insure complete combustion at this point. The absence of holes in the sides of the burner tube is cited by the makers of this torch as one of the reasons why it cannot blow out in a gale of wind.

In blow torches, a very common source of trouble has always been the enlarging of the fuel orifice by strong

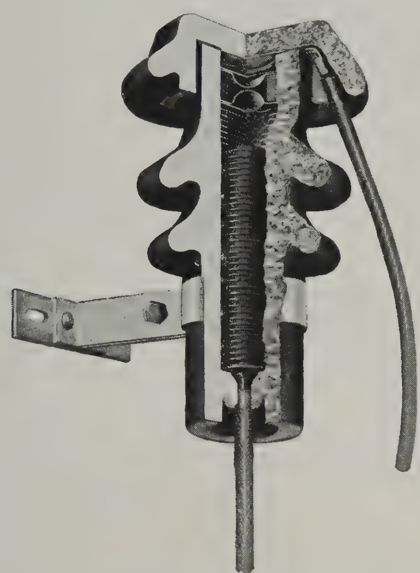
Double Jet Hot Blast Torch With Cut-away Sections to Show Details

arm work at the hand-wheel. To checkmate that form of abuse, the shut-off valve is separated from the fuel-control valve, the latter being placed above the shut-off. For the same reason the needle valve has only a small thumb-nut control so as to make it practically impossible for the operator to exert enough pressure to enlarge the orifice. The larger wheel has only one use—that of opening or closing the fuel line. As its valve has a positive seat, there is never any occasion to use force on this wheel.

The Master torch has a wooden pistol-grip handle hung at an angle that balances the torch and at the same time gives ample room for the largest hand so that the knuckles do not nearly touch the tank. The use of a single length of curved steel tubing to carry the fuel from tank to torch eliminates all soldered or threaded joints and connections.

Autovalve Distribution Lightning Arresters

Experience has shown that with arresters of the gap and resistance type no radical reduction could be made in the discharge resistance, because of the limitations imposed by the follow of power current after a discharge. The electrolytic arrester has the desired valve characteristics, that is, it does not permit the flow of any current due to line voltage, but merely passes current due to the excess over line voltage. The cost and the complications of structure and maintenance in this device, however, make it unsuited to the protection of even the smallest distribution transformers, distributed irregularly over a very wide area.



Cross Section of 7500-Volt Arrester

A 2500-Volt Arrester Mounted at the Extreme Right of the Cross Arm—The Arrester is Installed on a 4000-Volt Grounded Neutral Crcuit

As the result of research work by the Westinghouse Electric & Mfg. Co., a new principle was evolved in the autovalve arresters.

The basis of the construction is a unit consisting of a very short spark gap between electrodes of considerable area, which are made of material of considerable resistivity. The resistivity of the electrodes forces the discharge in the gap to spread out over the area of the electrode, thus preventing the localization of the current and preventing the formation of hot spots. So long as hot spots are prevented, the discharge does not become an arc, but remains in the form of a "glow discharge."

The working parts of the autovalve distribution arresters consist of a column of flat circular discs, 1/8" thick and 2" diameter, separated by thin mica washers 3 to 5 mils thick. This column is connected between line and ground through a series spark gap. The number of discs is made directly proportional to line voltage. Discs and gap are enclosed in a porcelain casing with a line lead brought out at the top and a ground lead at the bottom. The arresters are arranged for mounting on cross-arms by means of galvanized steel mounting brackets. The brackets are arranged to permit mounting of the bracket alone on the cross-arm and assembly of the arrester in the bracket after it is mounted. The arrester is merely dropped into a ring provided in the bracket and a clamping screw tightened to secure it in place. To suit various connections, the arrester may be turned in the bracket at any angle desired.

Calorac Portable Electric Rivet Heaters

The latest types of electric rivet heaters, manufactured by the Humil Corporation, New York, have a number of distinctive features, the most important of these being flexibility in operation, permitting the efficient heating of a wide range of sizes without the usual burning of the smaller rivets on machines of the higher ratings, and at the same time permitting the heating for non-continuous service of the largest rivets on the smallest machines.

Low power consumption, or high efficiency, has been secured by generous proportioning of copper and iron in the special type transformer, also by heavy cross sections in the long flexible leads that are autogenously welded into the pure copper electrodes or heads. This latter arrangement marks a radical departure from previous practice in that the contacts and leads can be readily renewed without disassembling the machine. Their length and high flexibility are such as to permit operation at the foot pedals at between 10 and 15 lb. pressure, thus avoiding the tiring effort of pressing against a heavy spring and preventing squashing or upsetting the ends of the rivets being heated.

Regulation against heavy power surges on starting the heating action, and the maintenance of high power factors (79 to 94), are obtained by means of air gaps in the transformer magnetic circuit. The high efficiency and power factor is also maintained through placing the transformer low in the machine and remote from the radiated and conducted heat from the rivets. Air spaces, provided between the coils, permit a constant stream of cold air to pass up through the transformer, cooling it constantly and enabling it to maintain high efficiency under continuous full load.

All of the coils are positioned around a separate center core, the secondary coils of heavy cast copper completely enclosing the core, except for a small gap at the top to provide the open circuit necessary. This design provides for the complete cutting of all magnetic lines by both primary and secondary coils. The primary coils are wound with

bare strip copper, insulated with asbestos and mica tape. This provides for rapid dissipation of the heat to the vertical air spaces and at the same time eliminates high voltage between layers of windings.

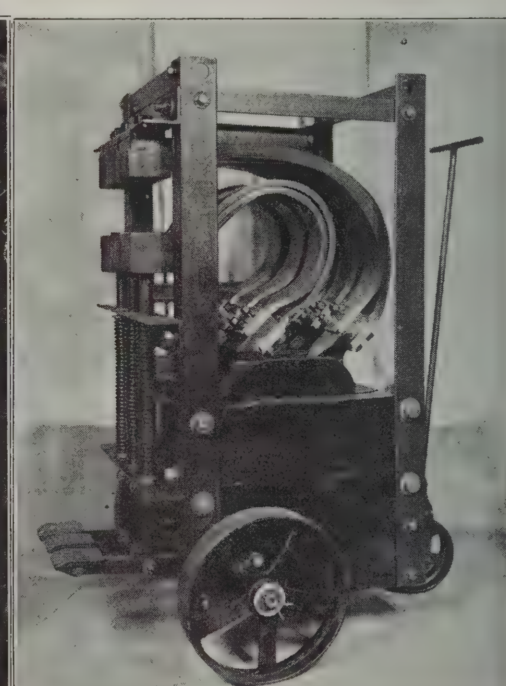
Stability and portability are secured in the Calorac heaters by keeping the center of gravity low in the frame and mounting the machine on large traction wheels. Provision has also been made for lifting by crane.

Close regulation of the power applied to the rivets is obtained by a five-speed controller, so mounted as to be readily accessible to the operator, thus permitting him to govern his production rate accurately. On the smallest two-contact Type A-2-H machine, rivets 1/4 in. by 1 in. can be heated at the rate of 720 per hour, while in the same machine rivets 5/8 in. by 2 1/4 in. are said to have been heated at the rate of 150 per hour. This same machine is also capable of heating much larger rivets. The large Type C heaters, when equipped with three or five sets of heating contacts, are capable of reaching a high production of hot rivets of the largest sizes. These machines are well adapted to heating the large mudring rivets used in locomotive boilers.

Rivets heated by this process are hotter at the cores than on the outside, as the heat is generated within the rivets themselves, and consequently it follows that they hold their heat considerably longer than rivets heated by external application methods. The avoidance of currents of oxidizing gases produces rivets free from scale, and this, with the hotter and more plastic central zones characteristic of rivets heated by this process, ensures faster, tighter, and cleaner riveting with less chance of loose rivets.

Referring to the illustration, the simple, rugged design of this heater is apparent. Hard usage with small expense

Calorac 3-Head Portable Rivet Heater on Boiler Work



Side Plates Removed Showing Rugged Construction

for up-keep were prime considerations in its design. Built entirely of steel, iron, copper, asbestos and mica, it is practically fire-proof. Heavy impregnation of all coils with the highest grade of insulating varnish render this heater waterproof as well. Safety of the operator is secured by the shielding of all live primary parts, while the electromotive force at the heads is so low that it cannot be felt by bare hands, this voltage never exceeding 3 volts. The machine is designed to be fool-proof and fire-proof. The comfort of the operator as well as that of other men in the shop is assured by the absence of smoke and fumes, with a resultant favorable effect on output.

Three New Westinghouse Products

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed several heaters of the type illustrated in Fig. 1, to be used for heating offices,

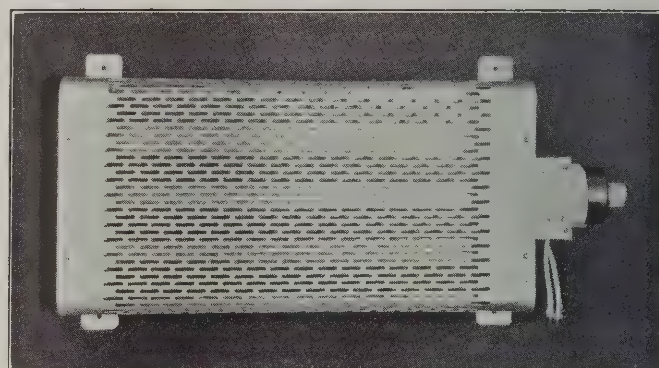


Fig. 1—An Easily-Regulated Electric Heater

shops, watchman's shanties, etc. They are safe, neat in appearance and convenient. They are not affected by varying gas pressures and can be installed in the most desirable location without regard to steam or gas lines. The heat is easily regulated by means of a convenient three-heat switch. The cost of installing this form of heating apparatus is much less than that of most other forms and the operating cost is relatively low.

Westinghouse electric glue pots (Fig. 2) are light,

sturdy and safe. They may be used for heating materials with low melting points such as paraffin, beeswax, etc., as well as glue. They are being used in many industries where the features of safety, convenience, dependability and uniformity of operating conditions are important. They are of the dry type to eliminate the danger of boiling dry and burning out the heating element, the inconvenience and sloppiness of constantly refilling the water bath, and to reduce the amount of current used in operating the pot.

The most important feature of the new electrically-heated solder pot (not illustrated) is convenience, com-

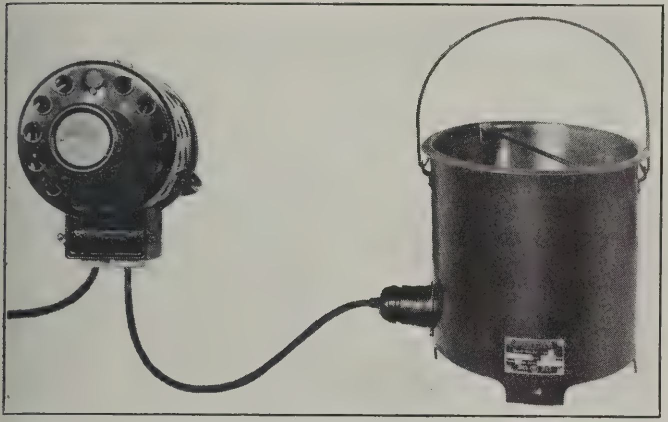


Fig. 2—Convenient Melting Pot for Glue, Paraffin, etc.

bined with the elimination of the fire hazard. Westinghouse small electrically heated solder pots are made in 10 and 30 lb. sizes and may be used to heat solder, babbitt, battery compound and other materials having a low melting point. They are equipped with three-heat switches, which permit the solder to be quickly melted on the high heating rate and kept at the proper temperature on a lower rate, without further attention. They are built to withstand hard usage and be dependable in operation. The heating chamber is thoroughly insulated, making the pot economical in operation and comfortable to work around.

New Method of Flexible Staybolt Inspection

As far back as 1916 a method of testing flexible staybolts were developed by the Flannery Bolt Company, Pittsburgh, Pa. At that time, however, the method had not progressed beyond the experimental stage and it has taken seven years to bring the method to its present state of perfection. Actual locomotive service tests covering the past three years are said to have demonstrated that the method as now developed is a positive means of determining the conditions of flexible staybolts in service.

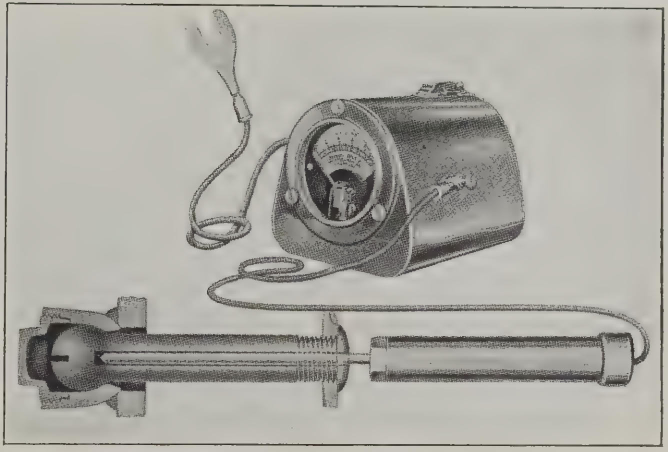
No method of testing that depends upon the human element should be satisfactory where danger to human life is concerned, and innumerable reports can be produced to prove the uncertainty and inefficiency of present methods.

The human element is practically eliminated by the new method of inspection which requires no change in the standard parts of a flexible staybolt assemblage with the exception of providing a bolt with a tell-tale hole extending from the inner end into, but not through, the head of the bolt.

Inspection is accomplished by establishing electrical contact at the extreme inner end of the tell-tale hole by means of a device consisting of a meter, batteries, an indicating rod and connection to the boiler. The apparatus is simple and compact and requires no particular care except the occasional renewal of a dry cell battery.

Reference to the illustration will indicate how the tester works. The connection to the boiler may be made at any point where good contact can be secured and the indicating rod is inserted in the tell-tale hole. As soon as the tip of the rod has reached the end of the tell-tale hole, the electric circuit is completed and is registered on the meter, thus insuring the tell-tale hole being open its full length and properly functioning. If the indicator rod is stopped before the meter indicates contact, this shows the hole to be obstructed in some manner. In this event, the hole is cleaned by means of a drill and small motor until contact can be established.

The method of testing is simple and there is no phase of the test that depends upon the human element, except the simple act of inserting the testing rod into the tell-tale hole. If the bolt is fractured, this will appear in the hydrostatic test which is applied after electrical contact has been made with all the bolts. The tell-tale holes being



Flannery Equipment for Testing Flexible Staybolts

clean will immediately indicate a fracture by water leakage from a bolt that is defective.

To insure clean tell-tale holes a fireproof, easily removable, porous cement is provided to seal the end of the tell-tale hole after the bolts are installed and riveted. Occasionally a mechanic may neglect to seal a hollow Tate bolt with the porous cement and in that event a small drill should be used to bore out the tell-tale hole preliminary to inserting the testing rod for inspection of the stay bolt.

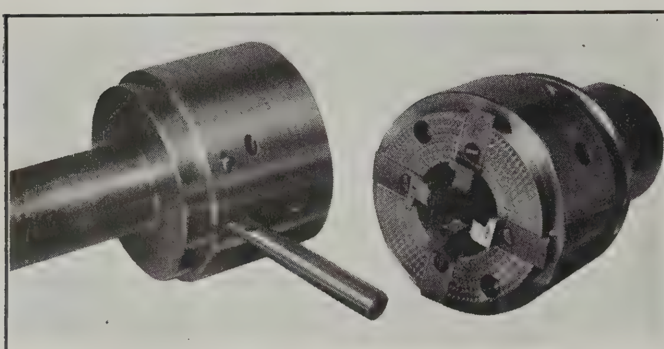
If the tell-tale hole has been sealed with the porous cement, sediment or any other obstruction that would prevent contact between the testing rod and the end of the tell-tale hole can only come from a fractured bolt. This will be readily indicated when the hole is cleaned and when the hydrostatic test is applied.

New Hardened Die

The National Acme Company, Cleveland, Ohio, has added to its line of Namco dies a new hardened die made in revolving and non-revolving types as shown in the illustration. These dies are featured by simple, strong construction. The body and shank is made in one piece, also

the cam and cup. The chasers bear directly against the solid cup cam, eliminating numerous small parts subject to wear and loosening. There are only ten parts used in the construction of this die (except for chasers) and there is no face cap to hold the chips and grit.

Special alloy steel is used throughout in the construction of this die and the cup wall is made unusually heavy. The chasers are fitted to hardened and ground plates, all parts being hardened and fully ground. Particular attention is given to the construction of the chasers, all chasers being hardened and lapped and ground on the bottom.



Namco Hardened Non-Revolving (left) and Revolving (right) Dies

The chasers receive full support, giving rigidity in cutting action. Projecting chasers permit threading close to a shoulder and provide freedom from chips.

The shanks for dies are made either soft or hard as desired, a hardened plate for the screw being used with the soft shank. Inside trip can be furnished if desired.

In the revolving type die, five straight thread sizes from 3/16 in. to 2½ in. can be provided; also four sizes of pipe threads from ⅛ to ¾ in. In the non-revolving type, seven sizes of straight threads up to 3 in. can be furnished and pipe threads from ⅛ in. to ¾ in.

Electric Glue Pot

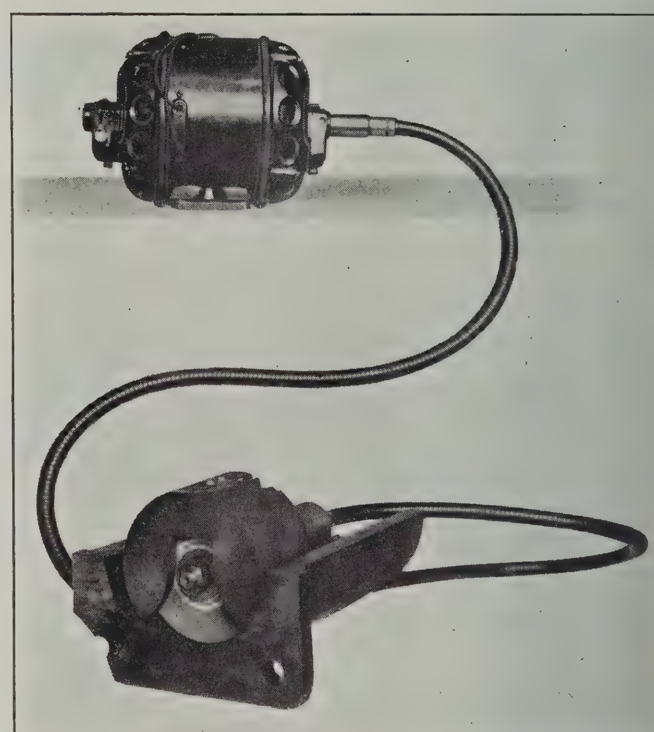
An electric glue pot which operates without a thermostat or water pot is being manufactured by the A. Stokes Company, 4097 East Seventy fourth street, Cleveland, Ohio. The temperature in the glue pot reaches the desired value within 30 minutes after the switch is turned on. The pot keeps the glue between 140 and 150 deg F. without the use of thermostats or thermometers. It is so designed that when the temperature reaches 150 deg. enough heat is radiated to keep the temperature from rising any higher. To prove this point, the current was kept on continuously on one of the pots for one month and at no time during that period was the temperature above 150 or below 140 deg.

The Stokes Automatic Electric Glue Pot

The pot was designed to eliminate waste caused by overheating. Overheating glue causes it to lose much of its strength and repeated overheating will cause it eventually to become insoluble. The electric glue pot is very simple in construction and is furnished for all standard voltages.

A Portable Adjustable Grinder

A portable adjustable grinder, for the removal of excessive metal or high spots from cylindrical surfaces, has been recently placed on the market by the Allan Manufacturing & Welding Company, Inc., of Buffalo, N. Y. The device is offered to the trade under the name of the "Cyl-Grind" grinder. The grinder is designed so that it may be adjusted or set to the desired radius to remove only the metal projecting above such radius, leaving a smooth ground finish. The adjustment may be made while the wheel is in motion and the legs of the main housing are resting on the cylinder wall. The Cyl-Grind is made in two sizes, the type A, principally for automotive cylinder blocks, and type B, for air, steam and water cylinders of large diameter. It may be also used to good advantage on flat surfaces. The device may be purchased with or without driving motor and flexible shaft as desired.



Showing Application of "Cyl-Grind" Grinder

The photograph illustrates the flexibility of the shaft and shows the manner in which the grinder may be applied to the grinding of a cylinder wall.

General News Section

George E. Stringfellow, district office manager of the Edison Storage Battery Company, at Washington, D. C., has been appointed sales manager with office at Orange, N. J., succeeding F. R. Blair.

The Norfolk & Western R. R., Bluestone, W. Va., is remodeling its power house by the installation of two Westinghouse underfeed stokers with extension sidewall tuyeres and the new type air distributing boxes.

The Magnus Electric Co., Inc., New York. Manufacturers of electrical specialties, wiring devices and radio accessories, have established a new district sales office at 231 N. Wells street, Chicago, Ill., in charge of Leo Hirschfeld and M. B. Geiger.

The Howell Electric Motor Company, Howell, Michigan, announces the election of the following officers for the ensuing year: W. M. Spencer, president and treasurer; R. B. McPherson, vice-president; C. F. Norton, vice-president and general manager; and H. T. Proctor, secretary and assistant treasurer.

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces the appointment of H. D. Baker, 525 Woodward avenue, Detroit, Michigan as its representative in the State of Michigan. Mr. Baker will handle the Roller-Smith Company's lines of instruments, circuit breakers and radio apparatus in that territory.

The National Carbon Company, Long Island City, N. Y., has completely equipped an emergency service plant, where motor brushes, contacts, etc., can be secured on short notice on the Seventh Floor of the Arrott Building No. 3, Pittsburgh, Pa. This is the third of a series of emergency service plants operated by the carbon products division of the National Carbon Company, which has been installed during the past two years, the other two being located at 237 East 41st street, New York City, and 560 West Congress street, Chicago, Ill.

In the derailment of passenger train No. 3 of the Atlanta, Birmingham & Atlantic, near Hatley, Ga., on June 11, about 1 a. m., 19 passengers were injured, and nearly all of the passengers in one coach were almost drowned. The derailment was due to the failure of a culvert because of heavy rains, and two coaches were ditched and partly submerged. The reports say that the electric lights in the coaches were not extinguished; and that but for this favorable circumstance a number of passengers who were completely immersed would probably have been drowned.

The Moffat Tunnel Act, which provides for the financing of a six-mile tunnel through the Continental Divide on the line of the Denver & Salt Lake Railroad by assessment on the property included in an improvement district served by this railway, was held constitutional in a decision of the Supreme Court of the United States last week. In December, 1922, the Colorado Supreme Court handed down a unanimous decision upholding the constitutionality of the act, in a friendly suit which was brought to test the validity of the bonds which are to be issued to finance the work. The case was then carried to the United States Supreme Court.

James C. Bennett, comptroller of the Westinghouse Electric & Manufacturing Company was elected a director of the company, June 13, in the place of John R. McCune, who died May 14. Mr. Bennett entered the employ of the company almost immediately after graduation from high school in 1886 as assistant to the auditor. Inasmuch as the company had been founded only five months prior to this time, he is one of its oldest employees. Mr. Bennett is also an officer and director of a number of the Westinghouse subsidiary companies. Edwin F. Atkins of E. Atkins & Company, Boston, Mass., Samuel M. Vauclain, president of the Baldwin Locomotive Works, Philadelphia, Pa., and E. M. Herr, president of the Westinghouse Electric & Manufacturing Company were re-elected.

The Illuminating Engineering Society will hold its 1923 convention September 24 to 28 inclusive, at Lake George, New York. The headquarters of the convention will be at the Fort William Henry Hotel. A well planned program of commercial and technical papers has been prepared by the committee on papers under the direction of J. L. Stair of Chicago. Lake George is one of the most picturesque resorts in America. The lake is 32 miles in length and from ¾ of a mile to 4 miles in width. The unique program of entertainment is being provided and unusually spectacular lighting features are being planned. It is hoped to combine business and pleasure at this convention in a manner to enable all visiting delegates to enjoy this wonderful country of mountains and lakes.

Annual A. R. E. E. Meeting to Be Held Early in November

The Association of Railway Electrical Engineers held a meeting in Chicago, Ill., on June 19, which included the executive committee and all of the chairmen of the technical committees. Progress reports were presented by the committee chairman and preparations made for the annual meeting which will be held in Chicago on November 6, 7, 8 and 9 at the La Salle Hotel.

Philadelphia & Reading Improves Terminal

Work on the new $3,000,000 Camden (N. J.) Terminal of this company's seashore lines is being pushed rapidly. When it is completed it will provide extensive additions to the company's ferry and track facilities necessary for the proper handling of its growing seashore traffic. Practically all of the extensive fill-in required has been completed. Work has also been finished on the laying of the foundations for the ferry slips.

Workmen are now putting in the foundations for the building and are grading the yard and laying the tracks. The contract has been awarded for the interlocking and bids for the signal tower have been asked for. It is expected that the erection of the steel work will begin about July 15. The plans for the new terminal call for a two-story structure of steel frame and brick with stone trimmings on a concrete foundation built on piles. It will house the electrically operated ferry slips, the train shed containing 14 tracks, a concourse 328 feet long and 105 feet wide, waiting rooms for men and women, a restaurant, and the offices of the Delaware River Ferry Company and of the seashore lines of the Philadelphia & Reading Railway.

Broad Street Station Re-Opened

The Broad Street Station of the Pennsylvania Railroad, Philadelphia, in which business had to be suspended on Sunday night, June 10, because of the destruction by fire of the train shed, was by Tuesday night, June 19, handling a large proportion of its normal traffic. Large numbers of carpenters and other workmen carried on the restoration of tracks and platforms day and night; and by the 19th all of the 16 tracks in the station were restored to use; but not all of them could be used for passenger trains as the traveler to support the workmen who are taking down the arches of the roof rested on tracks 7 and 10; and from the traveler there was an apron extending to the sides of the shed resting at its outer ends upon tracks 1 and 16. Tracks 8 and 9 were used by the work trains carrying off material. Twelve electric suburban trains were run from the station on Monday, the 11th, temporary platforms having been built at the outer end of the train shed, with stairways leading down to the side street. On Tuesday 155 trains used these temporary facilities, and on Wednesday some of the platforms and tracks were completed to the head house, and the temporary platform was abandoned.

Electrification in Sweden

The State Railway Administration of Sweden has asked the government for authority to begin immediately the electrification of the railroad from Stockholm on the Baltic Sea to Gothenburg on the North Sea, a distance of 300 miles. There is a heavy freight and passenger traffic between these two points. The sum of $6,300,000 has already been appropriated for the apparatus, and it is believed the work will be completed in two years.

This is an important step in the great movement which has already resulted in the electrification of hundreds of leading industrial establishments and at least 50 per cent of all of the farming area in Sweden.

Automobile Accidents at Highway Crossings

Accidents involving automobiles and automobile trucks at highway crossings have increased since 1917 about 50 per cent, according to a memorandum for the press prepared by the Bureau of Safety of the Interstate Commerce Commission. In that year there were 2,076 such accidents, resulting in the death of 1,083 persons and the injury of 3,000, while in 1921 there were 2,940 accidents, 1,259 persons killed and 3,976 injured. Mail and telegraphic reports made by the railroads to the bureau for the week ended June 2, 1923, show 35 fatal accidents of this character, causing the death of 55 persons.

The Worst Accident in History—350 Lives Lost

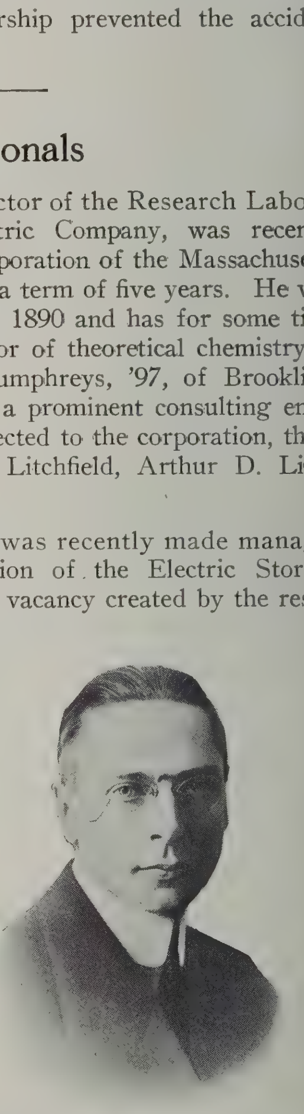
On June 17 at St. Michel in the Department of Savoie the French Minister of War unveiled a monument in memory of the 350 soldiers who lost their lives on November 12, 1917, in the derailment of a troop train at St. Michel.

The troops, numbering 500, had been fighting with the Italians in the Piave and were returning on leave. As the train was to leave Modane, the first town within French territory, the engineman refused to move saying the train was too heavy to be held by the locomotive or the brakes. The military commandant, however, ordered him to proceed with the result that the train went wild. Applications of the brakes set the cars on fire and the burning train left the rails near St. Michel, crashing into a stone bridge. Less than 150 of the 500 soldiers survived. The French censorship prevented the accident from becoming known.

Personals

Dr. W. R. Whitney, director of the Research Laboratory of the General Electric Company, was recently elected a member of the corporation of the Massachusetts Institute of Technology for a term of five years. He was graduated from M. I. T. in 1890 and has for some time been a non-resident professor of theoretical chemistry at the institution. Walter Humphreys, '97, of Brookline, and Charles R. Maine, '09, a prominent consulting engineer of Boston were also elected to the corporation, these three succeeding Paul W. Litchfield, Arthur D. Little and Eben S. Stevens.

William H. Palmer, Jr., was recently made manager of the railway sales division of the Electric Storage Battery Company to fill the vacancy created by the resignation of Harry B. Marshall, who left the company to engage in a private business enterprise. The Electric Storage Battery Company has expanded its railway sales division to meet the needs of increasing business. Two separate departments have been organized within the railway sales division to handle the car lighting and signal and car control battery business.



William H. Palmer, Jr.

With the exception of a few years devoted to other interests closely allied with the storage battery industry, Mr. Palmer has been

associated with The Electric Storage Battery Company since August 1, 1894. His headquarters will be at the general offices and works in Philadelphia.

Thomas L. Mount has been appointed manager of the car lighting department and H. B. Crantford, manager of the railway signal department. Both will serve under Mr. Palmer.


Thomas L. Mount

Mr. Mount has been intimately associated with the development of railway car lighting by electricity for the past eighteen years. He was employed by the Consolidated Railway Electric Lighting & Equipment Company, successively as draftsman, machinist, foreman and on the road installing, maintaining and operating some of the first axle lighting equipments, using the Manchester type of Exide Batteries. Later he became a member of the sales staff and eventually vice-president of the Consolidated Railway Electric Lighting & Equipment Company, in charge of sales and engineering. In 1919 he entered the service of the engineering department of the Electric Storage Battery Company. Later he was transferred to the railway division in connection with car lighting equipment sales.


H. B. Crantford

Mr. Crantford has been in the railway sales department from 1919 until 1923 and made his headquarters in Chicago. Prior to that he was engaged in automatic signal and interlocking installation and maintenance for the General Railway Signal Company. He served as signal maintainer and foreman on The Northern Pacific Railway and on the Chicago, Milwaukee and St. Paul Railway. Mr. Crantford also served as supervisor of signals, telegraph and telephone for the electrified zone of the latter company.

Both Mr. Mount and Mr. Crantford will make their headquarters in the General Offices of the Company at Philadelphia.

Franklin S. Terry, co-manager of the National Lamp Works, Nela Park, Cleveland, was elected vice-president of the General Electric Company and B. G. Tremaine, also co-manager of the National Lamp Works, was elected a director of the G-E Company at a recent meeting of the board of directors held in New York City.

Mr. Terry was born in Ansonia, Conn., in 1862. His first position was with the Electrical Supply Company of Ansonia, April, 1880, to October, 1884. In the latter month he went to Chicago to establish a branch of the above company, with which he continued until December, 1893.

In 1889 he organized the Sunbeam Incandescent Lamp Company of Chicago, of which he took personal charge on leaving the Electrical Supply Company, directing his energies to the improvement of the product and demand for various types and designs of lamps. May 1, 1901, Sunbeam Company was purchased by the National Electric Lamp Company, founded by J. B. Crouse, H. A. Tremaine, F. S. Terry, B. G. Tremaine and J. Robert Crouse. In 1911 the National Electric Lamp Company merged with the General Electric Co., Mr. Terry continuing with the National Lamp Works at Nela Park, Cleveland, Ohio, Mr. Terry and Mr. B. G. Tremaine being managers.

Mr. Terry was a pioneer in incandescent lamp business, a promoter of progress in electric lighting, a genius for organization. He was one of the organizers of N. E. L. A. in February, 1885, at Chicago and served for many years on the Incandescent Lamp Committee. He is personally interested in prosperity and happiness of associates and employees. During the war period he was active in French relief work. He was also interested in Red Cross classes in the factory, Liberty Bond and Red Cross campaigns.

Mr. Tremaine was born in Ann Arbor, Michigan, in 1863. He left school at the age of seventeen to enter business in Columbus, later going to Cleveland to engage in the fire insurance business, where he organized a company.

His next venture in Cleveland was with a real estate concern, where for several years he was engaged in the construction and sale of houses. In 1898 he became connected with the Cleveland Gas & Electric Fixture Company, and in 1899 director and stockholder of an electric railroad corporation in Fostoria. While in Fostoria he helped organize the Fostoria Incandescent Lamp Company.

Up to this time, except for his continued partnership in the insurance company which he organized, Mr. Tremaine had in no way confined his efforts to any one particular line of work. But in the latter part of the same year, he made the acquaintance of Mr. Terry, then manager of the Sunbeam Incandescent Lamp Company. Prior to this meeting, both Mr. Terry and Mr. Tremaine had conceived the idea of bringing together the numerous lamp companies that were fighting to maintain their existence. In 1901, with the aid of Messrs. J. B. Crouse, J. R. Crouse and H. A. Tremaine, their purposes were realized and the National Electric Lamp Company had its inception. One by one existing lamp companies were taken into the National, of which Mr. Terry acted as general factory manager and Mr. Tremaine as general sales manager.

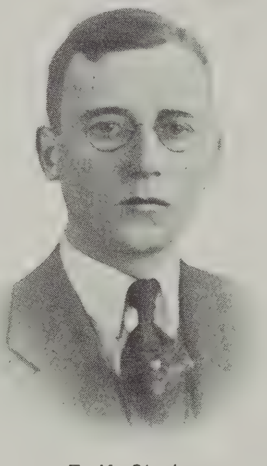
In 1911 the National Electric Lamp Company was dissolved and merged with the General Electric Company. Mr. Tremaine and Mr. Terry being respectively the Chairman and Vice-Chairman of its Advisory Board, and both extremely active in the business.

Louis R. Griffin was appointed as carbon brush engineer for the National Carbon Company, Inc., Cleveland, Ohio, on June 1, 1923, in which position he will be connected solely with the railway sales division of the company.

L. R. Griffin

Mr. Griffin was born in Chicago, Ill., May 20, 1891, and received his education in the public schools and high school of Englewood, later completing courses at the De La Salle Institute and the University of Illinois. He began his business career with the Badger Coal & Coke Company as a salesman and purchaser at mines. Four years later, he became service and sales engineer for the Buda Company in the railway department, in which position he remained for six years. After resigning from the Buda Company, he entered the sales department of the Badger Coal & Coke Company, where he remained until he accepted his present position.

Frederick K. Steel has been appointed office electrical engineer of the Great Northern Railway Company, with office at St. Paul, Minn. Mr. Steel was born August 28, 1898, in Great Falls, Montana. He was educated in the Montana State College, from which he graduated with a B.S. degree in electrical engineering. After finishing school he entered the service of the Great Falls Electrical Supply Company, where he was employed for about nine months. He resigned this position to accept his present one with the Great Northern, in which he attends to the office work of the electrical department, acting as assistant to E. Marshall, electrical engineer.



F. K. Steel

George H. Hawley has been appointed manager of the metal departments of the Standard Underground Cable Company's Perth Amboy, N. J. works, to fill the vacancy caused by the death of C. C. Baldwin, which occurred on June 7, last.

Mr. Hawley has been production manager for the past three years of the departments in question, which include the melting furnaces, rods, wire brass and tube mills, and those for the manufacture of weatherproof and magnet wire. He has had an unusually wide experience in such work and before going with the Standard Company was connected with the National Conduit & Cable Company at Hastings-on-the-Hudson, and for many years prior with the American Brass Company at Ansonia.

Calvin L. Jones, welding engineer of the Westinghouse Electric & Manufacturing Company, Atlanta, Georgia, has been elected vice-president of the American Welding Society. Mr. Jones has been elected for a two-year term and will be in charge of the activities of the society in the southern division.

E. W. McCord has been appointed chief clerk to E. L. Grimm, mechanical engineer and F. W. Reed, chief electrician, Northern Pacific Railway Company with office at St. Paul, Minn. E. W. Coby will fill the position formerly held by Mr. McCord and will do the accounting work in the electrical department.

Obituary

Chauncey C. Baldwin for more than twenty years connected with the Standard Underground Cable Company at Perth Amboy, N. J., died at his residence there June 7, 1923, aged 57, after a brief illness. He had been one of the outstanding figures in the copper rolling and wire drawing industry for many years. Starting first with Wallace & Sons as superintendent, later building and operating the Waclark plant at Bayonne, N. J., and afterwards the rod and wire mills of The National Conduit and Cable Co. at Yonkers. His connection with the Standard Underground Cable Company dates from 1902 as superintendent and manager of its metal departments at Perth Amboy, including its copper melting furnaces and equipment for the production of copper and brass rods and wire, tubes, weatherproof and magnet wire products. In 1916 he was elected a vice-president of that company which position he held at the time of his death. He took an active interest and part in local affairs and for some years past had been president of Perth Amboy Industrial Association. He was also a director of the First National Bank of Perth Amboy and other local interests.

Trade Publications

Large Conduit Fittings.—"Making It Easy To Pull Large Cables" is the title of an illustrated folder describing Mogul Condulets issued by the Crouse-Hinds Company, Syracuse, N. Y.

Lebanon Boiler Works, Lebanon, Pa., has recently issued a small 22-page booklet illustrating and describing principles and design of Uniflow improved return tubular boilers. The booklet shows a number of installations and also contains several useful tables.

Electrical Measuring.—The Thompson-Levering Company, Philadelphia, has issued a 32-page, illustrated booklet describing the testing sets, condensers, meters, galvanometers, pyrometers, rail bond testers, photometers, tachometers, thermometers, and other instruments of precision manufactured by that company.

The Fafnir Bearing Company of New Britain, Conn., has just issued the June number of the "Dragon," its monthly bulletin published in the interest of ball bearings. This issue contains an article on the subject of the manufacture of ball bearings, which is well illustrated with a number of instructive photographs.

Railway Electrical Engineer

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The Convention This Fall

In spite of the fact that the convention of the Association of Railway Electrical Engineers will be held a little later this year than usual, it is not too early even now to plan your work so that you will be able to attend. As has been noted before in the columns of the *Railway Electrical Engineer,* the convention will be held at the Hotel La Salle in Chicago from November 6 to 9 inclusive.

The absence of the semi-annual meeting in Atlantic City this year prevented any general get-together of the electrical men, a thing which is to be deplored, particularly since the electrical organizations of many roads are at the present time passing through a period of rapid growth.

There is much activity just now in the installation of new electrical equipment and the indications are that this activity will continue for some time to come. The benefits which the electrical men will derive from the annual convention this year will be perhaps greater than at any previous convention, not only on account of the nature of the reports to be presented but from the exchange of ideas outside of the convention hall.

In view of the present rapid development of electrical work, the need for the interchange of ideas is greater than ever before. The advantages accruing from this interchange are of incalculable value and the wise engineer will make every effort to attend the convention this year to find out how the other fellows are meeting their problems.

D., T. & I. to Electrify

The Ford News recently published an item stating that the Detroit, Toledo & Ironton is to be electrified. An abstract of the item is published elsewhere in this issue. Some rather loose statements are made such as, "The electric locomotive is much more powerful than the steam locomotive, and is approximately 50 per cent cheaper to operate" and, "It is capable of rendering practically continuous service, and can be inspected in one hour, whereas the steam engine requires several hours." Roughly these quotations are statements of fact, but the careful student or engineer would not try to use them quantitatively in speaking of any certain electrified line.

In the same item, however, are announcements describing definitely what the D., T. & I. equipment will consist of. The locomotives will develop a drawbar pull of 108,000 lb. at 25 miles an hour, will have a one hour rating of 5,000 hp. and will weigh 360 tons. The locomotives will have 16 driving axles and the voltage on the trolley will be 22,000.

A trolley voltage of 22,000 of course means that alternating current will be used and the highest trolley voltage in use at the present time in this country is 11,000. Doubling that voltage will probably introduce no serious difficulties, but the fact that it is to be doubled suggests further innovations. A locomotive with 16 driving axles is also somewhat out of line with the modern tendency toward 12 motors.

Mr. Ford's engineers are apparently not bound by tradition and it will be interesting to follow what may be developed. The knowledge of many skillful engineers can be used for developing this equipment and furthermore development work including the correction of minor faults after the locomotives are built will probably not be curtailed for lack of funds. It is entirely within the bounds of possibility that equipment which is radically different from any thing now in regular operation will be successfully developed.

Heat Treatment by the Electric Furnace

It is a well-known fact that heating by means of the electric current is comparatively an expensive proposition. This bald statement of fact, however, must be modified considerably under certain conditions as it may easily be possible, when all the factors are carefully weighed, to show that electric heating is really more economical than other methods. It must be admitted that is true only in particular cases, one of the notable examples of which is the heat treatment of steel by means of the electric furnace. With a correctly designed electric furnace results may be obtained in treating steel which are much superior to those secured by furnaces of other types. The great advantage which the electric heating method has over others is that the heat may be applied without the presence of air which inevitably results in the oxidization of the material being treated. Moreover, the control of the heat in the electric furnace can be made practically perfect and from the very nature of things the heating elements can be placed most advantageously with respect to the charge. The correctly designed electric furnace allows the charge to absorb the heat uniformly throughout so that warping and stresses are absent.

Examination of all classes of material from side rods to box car coupler pockets and arch bars, both by microphotographs, tensile and shop tests show remarkable conditions as existing in any ordinary forge shop practice. For example an arch bar picked out of a group was nicked and broken off with a sledge, whereas a second section which had been heat treated in the electric furnace was nicked, put into a rail straightener machine and bent

55 degrees out of straight in opposite directions four times before it cracked at the nicked position. Another bar which had been subjected to heat treatment but not nicked was bent similarly twenty times before cracking.

The cost of operating an electric furnace will of course vary with the cost of electric energy but on a basis of 6/10 cent per kilowatt hour the expense of treating 1,000 lb. of low carbon steel varies from 90 cents to $1.10.

This cost may or may not seem excessive depending to a very great extent upon the point of view. It is significant however, that in one plant where the process is carried on extensively it is regarded as an actual economy which unquestionably it is, as the results obtained from material treated in the electric furnace have fully justified the expense involved.

Motors and Centrifugal Pumps

Recently in several cases improper selection of centrifugal pumps has placed the electrical man in a peculiar position. Centrifugal pumps are among the most dependable kinds of machinery and will perform the work which is expected of them. Unless sufficient consideration is given to their characteristics, however, they may perform in a manner which will surprise the user. It is common practice on many roads to purchase a motor for a certain job that is somewhat larger than is really necessary. This results in a loss of efficiency, and a reduction of power factor if alternating current motors are used, but it provides a rugged and dependable power unit which will operate under adverse conditions with very little attention. When this general rule is applied to a pumping unit consisting of a centrifugal pump and a motor, the results are sometimes unexpected.

As an example, a railroad recently had need for a pump which would lift 150 gallons a minute against a 100-ft. head. With the intention of providing a pump which would have more than the required capacity, a pump was ordered which was designed for lifting 150 gallons a minute against a 120-ft. head. Had the designer or the manufacturer been consulted, the error would have been forestalled, but in this case, as in other similar cases, the pump was ordered without consultation, or it was a pump which had been previously used by the railroad on a different location.

When the pump was installed and put in operation, the motor ran hot with the result that a report was sent in stating that the motor was defective. An electrician was sent out on the job and he had three things to do; namely, find out that the motor was all right, discover that the pump was pumping more water than it was designed to pump and show the operators and the department that placed the pump that the motor was doing more than could rightfully be expected of it.

If the outlet valve of a centrifugal pump is closed, the load on the motor will be reduced by about 50 per cent. That will illustrate one point, but the pump must not be left for a long period with this valve closed or it will overheat. If it is possible to measure the delivery of the pump, it can be shown that the motor is doing more than should be expected of it, or if there is a pressure gage in the outlet line near the pump, the outlet valve can be throttled down until the head is equivalent to that for which the pump was designed and the load on the motor will drop to normal. These circumstances can cause much unnecessary work and may result in some disagreeable exchanges of opinion, but the case can be settled amicably and the trouble corrected if proper consideration is given to pump characteristics.

Letter to the Editor

Resistance of 30-Volt and 60-Volt Tungsten Lamps

To the Editor:

With reference to the questions on Page 217 of the July issue of the *Railway Electrical Engineer*, question 4 is one that cannot be answered unless one has available characteristic curves showing the relation between voltage, current and resistance for tungsten filament lamps.

To those not thoroughly familiar with the characteristics of Mazda lamps the answer to this question might seem to be that a 60-volt lamp on 30 volts would take 50 per cent of its normal current. This of course is not true, for the reason that a tungsten filament has a positive temperature coefficient so that its resistance when operated on 30 volts would be lower than when operated on 60 volts and hence the current would be more than 50 per cent of normal. It would actually be around 67 per cent of that taken by the lamp when operated on 60 volts. This brings to mind that there is an impression in some quarters that fluctuations in voltage have a greater effect on mazda lamps than on carbon lamps. The opposite of this is true, namely a given per cent increase in voltage will shorten the life of a carbon lamp by a greater percentage than it will a mazda lamp. This is due to the fact stated before, that the mazda lamp has a positive temperature coefficient hence the resistance increasing with increased voltage, the current and consequently the filament temperature do not increase as much as with a carbon lamp which has a negative temperature coefficient.

With regard to question 5, it is doubtful if there is any way that this can be calculated. The difficulty is that when two lamps of different ratings are connected in series neither lamp will be operating under its normal current and neither one will have its normal hot resistance. Without knowing the resistance the current cannot be calculated and without knowing the current the resistance cannot be calculated. In other words there are two mutually dependent variables, both of which are unknown. Fairly close approximate results could probably be obtained by a sort of cut-and-try method.

Anonymous

New Book

Biographical Directory of Railway Officials of America, 1922. 717 pages, 9 in. by 6 in. Bound in cloth. Published by Simmons-Boardman Publishing Company, New York. Price $6.00.

The 1922 edition of the Biographical Directory is the first edition since 1913. In includes, in alphabetical arrangement, concise professional records of more than 5,000 railroad officials, revised to September, 1922. Only 37 per cent of these appeared in the 1913 edition and only 13 per cent hold the same positions that they held nine years ago.

Train Used for Making Current Collection Tests

Contact System for Collecting Large Currents

Single Pantagraph Used to Collect 5,400 Amperes at 58 Miles an Hour Without Sparking

A SERIES of tests on a new type of overhead trolley construction were made during the week of July 16 by the General Electric Company on its tracks at Erie, Pa., for the benefit of a large group of invited guests. The trolley construction, which was developed by the General Electric Company, is extremely flexible and the tests show that as much as 5,400 amperes can be collected from a single pantagraph without sparking.

With the customary trolley wheel as used in the heavier trolley car service, the current collected ranges from about 800 amperes during acceleration down to 300 to 500 amperes running speed. On the Chicago, Milwaukee & St. Paul with a single double-pan pantagraph, the current collected ranges from 1,200 amperes accelerating to 800 amperes running.

For successful current collection it is essential that the contacts between the working conductor and the collector be maintained. Any irregularity in the contact that may cause visible arcing must be avoided. Arcing at the contact is a much greater factor in the deterioration of the contact wire and collector than the mechanical wear due to the sliding friction. The type of overhead construction developed at Erie is designed to comply with these essential characteristics and has demonstrated the possibility of collecting sufficient current to handle the heaviest trains.

The test train consisted of a 110-ton passenger type locomotive arranged for operation on 750 or 1,500 volts and equipped with four bipolar gearless motors, a gondola and a New York Central observation coach. On account of the short length of the cab, the second pantagraph was mounted on the gondola to simulate operating conditions. The normal pressure of the pantagraph against the trolley wire was between 30 and 35 lb. By means of remote controlled contactors, sections of loading grids indicated in the gondola were inserted or removed so as to draw whatever current was called for under each particular test.

Some of the guests were invited to ride in the locomotive cab. Others rode in the observation coach which was equipped with indicating instruments to show the amount of current collected and the speed of the train.

Five tests were made as follows: 1. With the train running at 60 miles an hour, one pantagraph was used to collect 4,000 amperes at 1,500 volts. 2. At a speed varying from 50 to 60 miles an hour, one pantagraph was used to collect 4,000 amperes at 850 volts. 3. At 30 miles an hour, two pantagraphs were used to collect 5,000 amperes at 850 volts. 4. At 60 miles an hour two pantagraphs were used to collect 5,000 amperes at 850 volts. 5. At 58 miles an hour one pantagraph was used to collect 5,400 amperes at 850 volts. It was necessary to make the higher amperage tests at the lower voltage because of the limited power available. Witnesses of the tests stationed on observation towers remarked on the complete absence of sparking.

To provide facilities, the General Electric Company made use of the eastern division of the East Erie Commercial Railroad. These tracks are equipped with up-to-date overhead line construction and third rail and are supplied from a substation with whatever trolley voltage may be required.

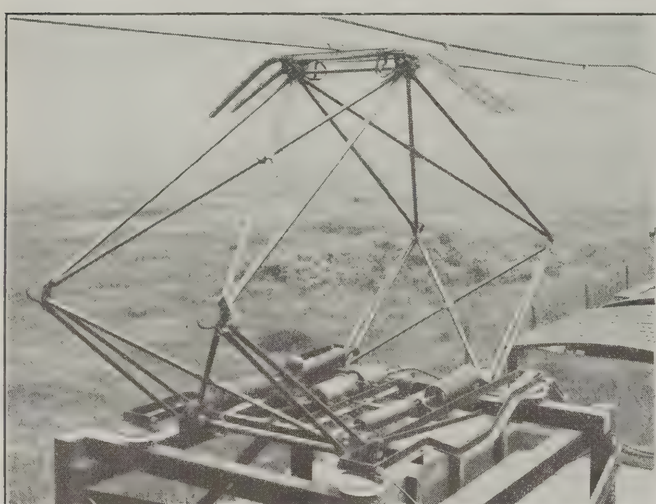
That portion of the track which is used for testing purposes is at present 2¾ miles in length. An extension is now under construction which will give a total length of 4¼ miles. The length of track used for high speed running is about 2½ miles long, the remainder being used for slowing down the train. Included in this high speed section, there is one mile of level tangent track. Beyond

this tangent there is a slightly ascending grade with curves of from 1 to 1½ deg. The rail used is of 100 lb. section which is laid with 24-in. tie spacing in slag or stone ballast. There is also about one mile of extra rail which is used for testing odd gage locomotives.

Overhead Construction

The working conductor is located 22 ft. above the rail. The overhead construction is compound catenary with a steel messenger and a socondary copper messenger to which is "laced" duplex copper contact wires. The two contact wires are supported at alternate points by the lacing. A portion of the secondary messenger is 1,000,000 c.m. copper and the remainder 750,000 c.m. The overhead line is fed at one point from the substation in building No. 60 of the G. E. plant.

The steel supporting structures begin about 600 ft. west



One of the Pantagraphs

of the substation with latticed column bridges extending up to bridge No. 13. Bridges No. 14 to 18, inclusive, are Bethlehem column bridges. The structures from No. 19

CALCULATED DATA ON THE SEVERAL SIZES OF LACED SUSPENSION

Weight and Resistance per 1,000 ft. with two No. 4/0 Copper Contact Wires and No. 0 Lacing

Feeder Messenger	Total C.M.	Weight	Resistance at 50° C. (122° F.)
1,000,000 c.m.	1,528,735	4,706 lb.	0.00752
750,000 c.m.	1,278,735	3,931 lb.	0.00899
300,000 c.m.	828,735	2,532 lb.	0.0139
No. 4/0	740,335	2,259 lb.	0.0155

Weight and Resistance per 1,000 ft. with two No. 6/0 Copper Contact Wires and No. 0 Lacing

1,000,000 c.m.	1,964,735	5,426 lb.	0.00587

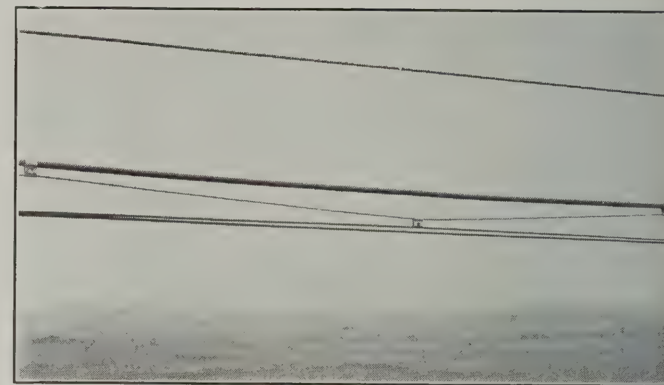
Basis

	Weight
Cable 1,000,000 c.m.	3.1 lb. per foot
Cable 750,000 c.m.	2.325 lb. per foot
Cable 300,000 c.m.	.926 lb. per foot
Cable No. 0 (106,000 c.m.)	.322 lb. per foot
Wire No. 4/0 (212,000 c.m.)	.64 lb. per foot
Wire No. 6 (330,000 c.m.)	1.00 lb. per foot

5 ft. overrun of lacing per 1,000 ft.
Assume 11.5 ohms per mil foot—temperature 50° C (122° F.)

to 23 are latticed channel bracket poles; from No. 24 to 28 inclusive, 10-in. Bethlehem bracket poles; from 29 to 33, inclusive, 9-in. Bethlehem bracket poles. Bridge No. 34 is latticed column type used for an anchor. The steel structures are spaced 300 ft. throughout. All of the steel structural work was supplied by the Archibald Brady Company, Syracuse, N. Y.

The primary messenger consists of a ⅝-in. 7-strand high strength steel cable, from structure No. 1 to 34. The secondary messenger is a 1,000,000 circular mill stranded copper cable between bridges No. 1 and 15, and a 750,000 circular mill stranded copper cable from bridges No. 15 to 34. From bridges No. 1 to 16 and from No. 20 to 34,



A Lacing Made of No. 0 Stranded Copper Wire Supports the Two Contact Wires at Alternate Points

the working conductor or contact wire consists of two 0000 grooved hard drawn copper wires hanging side by side. From bridges No. 16 to 20 two 000000 copper wires are used.

The laced suspension is installed throughout with a

Four of the Supporting Structures Are Latticed Channel Bracket Poles

No. 0 stranded copper cable supporting the contact wires from the secondary messenger. Droppers from the primary messenger support the secondary messenger at points 30 ft. apart. The working conductors are sup-

ported from the secondary messenger by clips spaced 15 ft. apart on each wire.

These clips are fastened securely to both the auxiliary messenger and to the contact wires and will not slide along the wires. Details of design for the dropper wires which

One of the Observation Towers

support the auxiliary messenger from the main messenger have not been worked out. At the request of one user of electric locomotives the droppers for a short section consisted of copper tubing, but for the greater part of the

Latticed Column Bridges Are Used to Support the First 13 Spans of Overhead Trolley

distance they were made of stranded steel wire served on to both messengers.

To permit witnessing conveniently the current collection observation towers had been erected to a height of approximately the top of the pantagraph, at various points along the track.

The substation contains two synchronous motor generator sets with switching equipment suitable for connecting these units to supply any trolley potential from 600 to 3,000 volts. One of these sets has a rated capacity of 1,000 kw. and consists of two 500 kw. 1,500/3,000-volt generators direct connected to a synchronous motor. The second unit is of similar construction but with two 750 kw. generators. Full capacity can be obtained with both series and parallel connection, and lower voltages can be obtained by adjusting the rheostats in the generator fields. Both of these sets are designed to operate at three times normal load for short periods, and a total of 6,000 kw. can be obtained, the limit of the power supply.

Electric Traction for the Detroit, Toledo and Ironton

According to the Ford News, rapid progress is being made on the new equipment at the Rouge Power House, which will furnish power for the electrification of the first unit of the Detroit, Toledo & Ironton.

The original boiler capacity consisting of four boilers rated at 2,647 hp. but developing more than 6,500 hp. each is being doubled. The present generating system consisting of two 12,500 kilowatt turbine generators is being replaced by eight turbine generators, each rated at 30,000 kilo volt amperes. The steel work on three of the giant stacks is already completed and one of the turbines, among the largest in the world, is also nearing completion.

The present plans, which will mark what the News terms a new era in the history of the Detroit, Toledo & Ironton in addition to the installation of the big turbine units at the Rouge Plant, call for the building of new locomotives, the construction of 13¼ miles of double track between River Rouge Plant and the Flat Rock yards and many other changes incidental to the electrification of the line.

In keeping with the general improvements that the Detroit, Toledo & Ironton has undergone under Ford operation, electrification will give the road a vastly superior motive power, the News says. "The electric locomotive is much more powerful than the steam locomotive, and is approximately 50 per cent cheaper to operate. It is capable of rendering practically continuous service, and can be inspected in one hour, whereas the steam engine requires several hours. Moreover, the electric locomotive becomes a generator on a down grade, putting current back into the wires, thus utilizing the otherwise wasted energy of inertia and gravity."

The account in the Ford News continues: "The new electric locomotive for the Detroit, Toledo & Ironton for freight service will weigh 360 tons, and have a normal capacity of 4,000 hp., and be capable of producing 5,000 hp. for an hour. They will have 16 driving axles and will develop 108,000 lb. drawbar pull at 25 miles an hour. The maximum speed will be 45 miles an hour. The power will be supplied by the River Rouge Power House. The pressure on the power transmission line will be approximately 150,000 volts, the trolley line carrying 22,000 volts.

"The new Ford line, the Detroit & Ironton, to be operated in conjunction with the Detroit, Toledo & Ironton system, is now making rapid strides toward comple-

tion. The construction work is assuming huge proportions. This new road will be the first division to be operated with electric motive power. The line is to be double-tracked and will connect the Rouge Plant of the Ford Motor Company with the Detroit, Toledo & Ironton north of Flat Rock, Mich. Although the Detroit & Ironton is to be but 13¼ miles long, it will effect enormous savings in switching charges between the Rouge Plant and the present Detroit, Toledo & Ironton terminus.

"A large amount of work has been necessary on the division between the Rouge Plant and Oakwood Boulevard in making fill for approaches and on construction of a temporary trestle over the Rouge River. This trestle will be replaced with a re-enforced concrete bridge.

"One very expensive feature of railroad construction is eliminated in connection with the Detroit & Ironton by the use of refuse sand from the Rouge Foundry for grading purposes. The tracks are being laid with 100-pound rail and creosoted ties. Each tie will be protected with tie plates, which greatly adds to the life of the ties as well as forming a more secure track.

"At present a force of 225 men are engaged in rushing this work to completion and it is expected that the latest addition to the Ford railroad interests will be operating in its entirety by October 1, 1923.

"In connection with this line, which may eventually become part of the main line of the Detroit, Toledo & Ironton, extensive receiving and classification yards are being built immediately below the Detroit & Ironton at Flat Rock. In these yards all incoming trains will be broken up and arranged for dispatch, thus expediting the delivery of shipments to the consignee."

Electric Locomotives for the Baltimore & Ohio

Two 120-ton, 600-volt locomotives for the Baltimore Tunnel of the Baltimore & Ohio railroad have just been shipped from the Erie factory of the General Electric Company. The locomotives are of the steeple cab type and have articulated trucks equipped with G-E 209 motors. The length of the locomotives inside knuckles is 39 ft. 6 in., length over cab, 33 ft. 6 in., height over cab, 12 ft. 4 in., overall width 10 ft. The dimensions of the operating cab are 10 ft. by 15 ft.

The construction of the locomotive is such that buffing and hauling stresses are carried through the truck side frames and an articulated joint, thus eliminating strains from the cab and platform. Multiple unit control and four third rail shoes are provided. The locomotives will haul a 1,200-ton train on level tangent track at a speed of 17 miles an hour and will haul the same train up a 0.5 per cent grade at 14 miles an hour.

Two 120-Ton Electric Locomotives for the Baltimore Tunnel of the Baltimore & Ohio

Tri-Plex Ammeter for 3-Phase Circuits

A type of alternating current ammeter has been recently developed by the Roller-Smith Company of New York, which makes it possible to take readings in three phases simultaneously, as contrasted with the usual scheme of having one ammeter and throwing it from one transformer secondary to another by means of a conventional jack, which is apt to cause interruption in the service when used in connection with ground relay protection. The mechanism is of the electro-magnetic type. An efficient air damping scheme is used. All three mechanisms are mounted on one rigid bakelite base to provide proper insulation and insure alinement of parts. Pivots of hardened steel, highly polished and first quality sapphires are used. The construction is dust, moisture and practically waterproof. Each scale is about 2¾-in. long. Dials of pure white Bristol board with prominent black inscriptions are well lighted and easily read. The glass fronts are cemented in place.

The Triplex Ammeter

The 5-Ton Unloader in the Foreground Is Used for Unloading and Cleaning Up

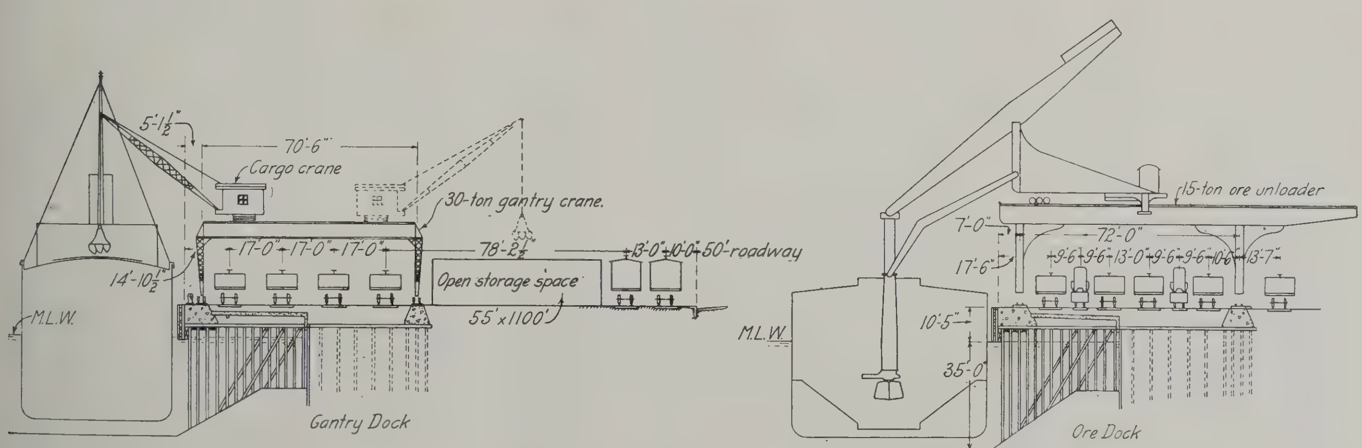
New Deep Water Terminal Put in Operation

Lehigh Valley Completes First Unit of Claremont Project for Handling Ore and Miscellaneous Freight

THE Lehigh Valley has recently completed and put into operation the first unit of its large Claremont pier and terminal development in the Greenville section of Jersey City, N. J. The Claremont project, in the ultimate, will conclude three piers each approximately 7,000 ft. long and separated by two slips 450 ft. wide and deep enough to accommodate vessels drawing up to 35 ft. of water. The first unit consists of a 3,500-ft. structure of combined pier and backfill construction upon which there have been located ore-unloading machinery, a large two-story freight house, an open storage space and loading tracks served by a gantry crane, machine shop, transfer table and a complete yard track system. Narrow-gage electric poling locomotives are used for handling cars, the layout being one of the largest installations of this kind. Five large steamers can be berthed at this pier at one time.

The new unit is located on the tidewater flats off Jersey City approximately midway between the Lehigh Valley's piers at Black Tom and Constable Hook. This property, which totals about 600 acres, adjoins the Greenville terminal of the Pennsylvania Railroad.

Briefly the project calls for the construction of three piers, two of which are 400 ft. wide including backfill with a double pier 700-ft. wide in the center. The lengths vary from 6,650 ft. for the north pier to 7,800 ft. for the south pier. These piers will be built inshore from the government bulkhead line for a distance of 3,000 ft. as a combination backfill and pier. The outer construction will be pile supported with a concrete deck. Facilities on the piers will include complete equipment and yard layouts for handling ore, coal, miscellaneous import and export freight, lumber and other products. Car movement will be across Newark Bay to the Lehigh Valley's Oak Island yard where classification will be made. Because of this it was necessary to provide for considerable yard trackage on the piers themselves. Plans have also been made for



Typical Sections of the Dock

a complete engine terminal to be constructed later on the filled inshore end of the project. It is estimated that from 12,000,000 to 15,000,000 cu. yd. of fill will be necessary.

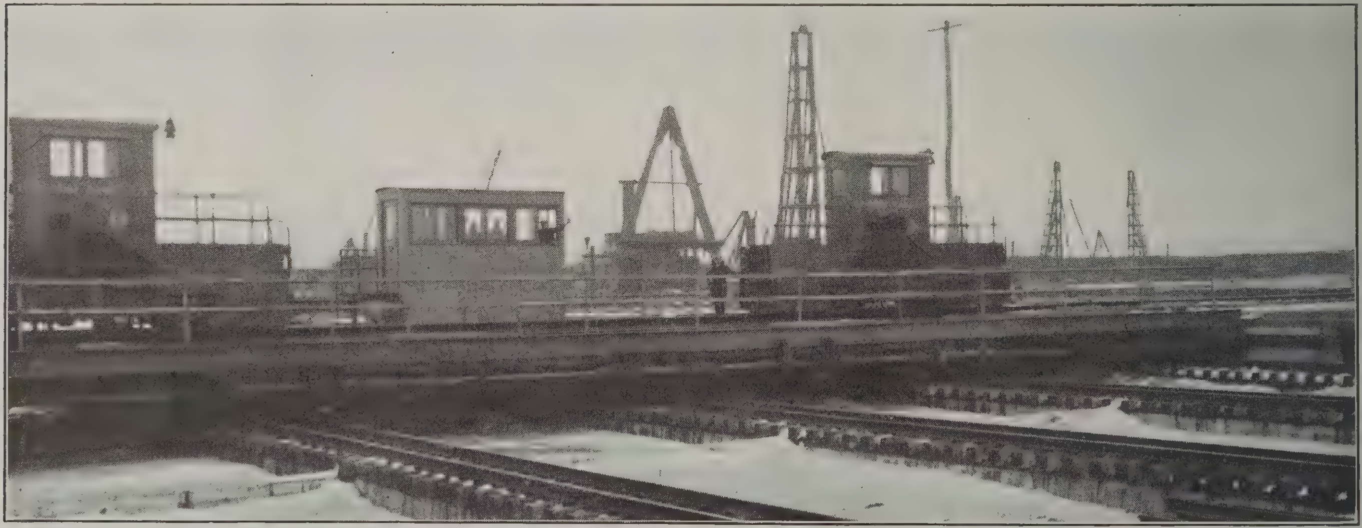
The Design of the First Unit

The first unit is the inshore end of the south pier extending from a point about 250 ft. outside the government bulkhead line with a wharf frontage of approximately 3,500 ft., including this extreme outer end upon which the transfer table is located. The outer section of the pier is utilized for the ore dock and provides berthing capacity for two vessels 500 ft. to 600 ft. long. This is equipped with one 15-ton ore-unloader of the bucket and boom type and one 5-ton machine of the cable and grab-bucket type. The next section includes a 127-ft. by 816-ft., two-story concrete freight house with sufficient adjoining space to permit of the berthing of two large ships. This section is adjoined on the inshore end by a 720-ft. open dock for one large ship and equipped with a 30-ton gantry with revolving crane, spanning four loading tracks and serving an open storage area. Each of these units is served by its own tracks.

This trackage consists chiefly of an empty storage yard for the ore-dock and a yard for the open storage and warehouse docks with capacities of 422 cars and 210 cars respectively. In addition to this trackage, there are three tracks for loaded cars, holding 25 cars each, an advance empty yard with a capacity for 70 cars, three repair tracks, six tracks serving the open storage space and the warehouse, and four tracks serving the ore-unloaders. Movement to and from the ore-unloaders has been arranged to provide for a one-way use of the tracks.

This unit is a combination of pier and back fill construction, the outer 40 ft. along the slip and across the end beyond the bulkhead line being on pile foundations. Different designs were used at the different sections of the pier, the heaviest construction being at the ore dock. In general, piles 55 ft. to 60 ft. long were driven in double row bents spaced approximately 12 ft. 6 in. apart with two short single row bents spaced between these under the wharf edge as additional foundation support for one end of the ore-unloaders. The tops of the caps are at an elevation slightly higher than mean high water. The wharf edge consists of a concrete wall. The remainder of the loading between this wall and the bulkhead is carried on a reinforced concrete slab 1 ft. 4 in. thick at an elevation slightly above mean high water. The bulkheading consists of a single line of 8 in. by 12 in. tongue and

The End of the Warehouse and the Open Dock Served by a 30-Ton Gantry Crane



The Transfer Table Has Been Designed for Quick and Efficient Movement of Equipment

grooved sheet piling. Under the warehouse the piling was driven in clusters under each column support in the usual manner. Closely spaced, single row bents were driven under the line of the back legs of the ore machinery and gantry crane, and concrete walls poured similar to those on the pier edge.

The line of sheet piling running across the edge of the pier was continued along the government bulkhead and connected with a stone dyke on the edge of the built-up, adjoining land of the Pennsylvania Railroad. The area between the shore, the sheet piling and the stone dyke was then filled by the material dredged from the channel. Actually the filling extended beyond the limits of the present development, a large part of the area lying inshore from the proposed units being built up to well above mean water level. A total of about six million yards was dredged, about one and one-half million of this yardage being taken up in the rehandling of material. This included a channel 300 ft. wide for the length of the first pier unit and 7,200 ft. of 250-ft. channel to deep water.

A String of Empties Being Fed Under the Ore Unloaders by Two Electric Locomotives

Transfer Table Speeds Up Operation

The outer end or ore dock is operated by the Bethlehem Steel Corporation, Bethlehem, Pa., which utilizes it for unloading its large vessels plying between the Port of New York and Cruez Grande, Chile, and for its smaller vessels plying between the port and Daiguire, Cuba. As stated, the operation of ore cars is one way. Empties are placed in a three-track yard and are fed by gravity to a lead of two tracks with a narrow-gage track between them. Here they are picked up in cuts of two on each track by an electric locomotive and placed on the transfer table. The handling of cars by the electric "mule" is carried out through the use of two air-operated poling arms which drop down on each side and between the ends of the car frames. In actual operation the two lead tracks to the transfer table are kept well filled with inbound empties to reduce the length of haul by the mules.

From the transfer table, the empties are "kicked" out onto the ore loading tracks, of which there are four. These tracks are interspaced by two intermediate narrow-gage tracks. The cars which are put off on these tracks are picked up by electric locomotives and spotted under the ore unloaders. Under peak operation two additional locomotives are used for the purpose of taking the loaded cars away and placing them in an outbound make-up yard of four tracks.

The transfer table which is the keynote of this operation takes the place of a drill track originally considered and permits of a faster and more economical operation. This table is a modern structure of heavy design and capable of moving four cars at a time on a three-minute cycle and also of moving steam locomotives should that be necessary. It is 105 ft. 4 in. long and 44 ft. 6 in. wide, and designed for E-60 loading. The pit is 137 ft. 10 in. long with a depth from pit rails to running rails, of 3 ft. 2 in. The pit rails consist of five lines of two-rail tracks, the transfer table having five sets of four-wheel trucks under each side. The transfer table is motor driven, the installation consisting of two motors driving 10 wheels on each side of the table. These units are designed for meeting the following conditions: (a) to move the table 94 ft. in 50 sec. when loaded with two barneys and four empties weighing 60,000 lb. each and (b) to move the table 94 ft. in 90 sec. when loaded with two barneys and one Class N-3-A engine with a total weight on axles of 480,000 lb.

An interesting feature of this table is the provision of two barneys, one for each standard-gage track. These barneys act as bumpers when empties are kicked onto the table, the electric locomotives seldom going onto the table. At the conclusion of the transfer movement, the

empties are kicked off the table and well down into the ore-loading tracks by the barneys, the amount of kick being under the accurate control of the transfer table operator. Both ends of the tables are provided with limit switches to prevent the overrunning of the barneys. When pushing two empties the movement is at the rate of 90 ft. in 25 sec.

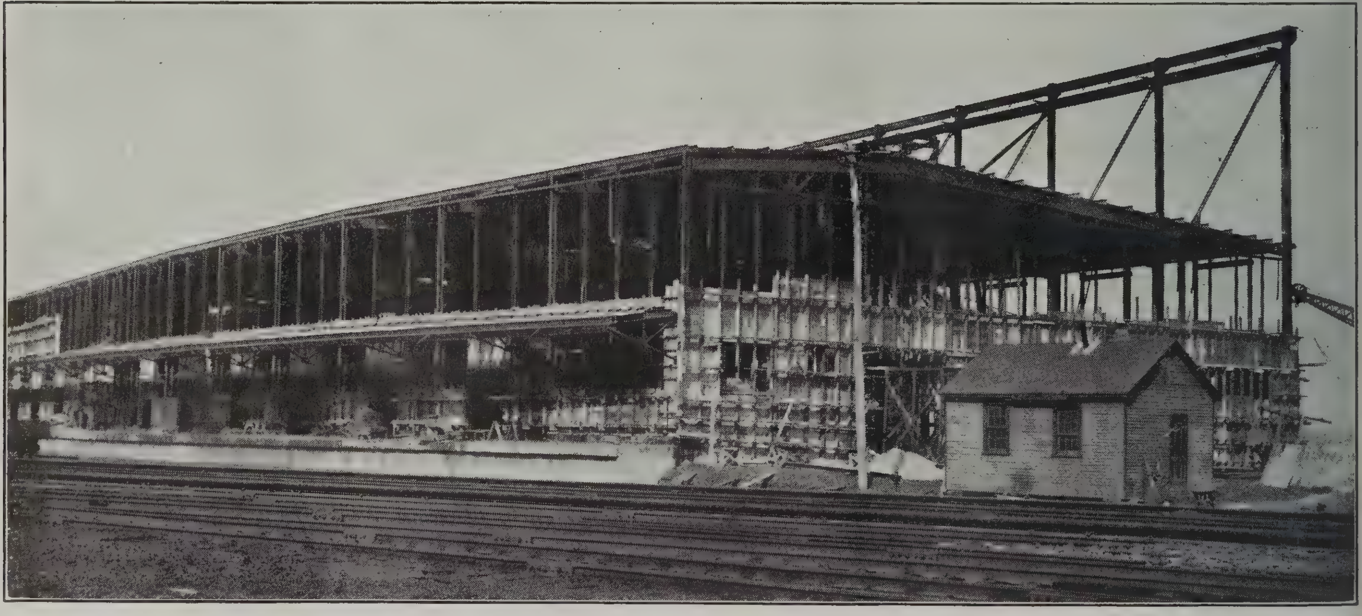
A Fireproof Freight House of Large Capacity

The warehouse, as stated earlier, is a two-story structure measuring 127 ft. wide and 816 ft. long with a storage capacity of about 600 cars of freight. A 12-ft. 6-in. covered platform extends the full length along the rear. It is of modern fireproof construction, being of concrete, terra cotta and steel with cement tile roofing slabs. It is divided into four sections by terra cotta fire walls. It is supported on piles, the clusters being capped with concrete pedestals spaced 24 ft. longitudinally and 33 ft. 4 in. transversely. These pedestals carry the steel column and girder construction for the second story and roof, and the cargo hoist and walkway. The sidewalls and end walls are of reinforced concrete, terra cotta being used only over the windows and doors and in the sidewalls near the firewalls. The flooring consists of 8-in. of concrete overlaid with 2-in. asphalt block paving on the first floor and 6-in. of reinforced concrete on the second.

The arrangement for door space and lighting is exceptionally efficient. On the dock side, practically the entire wall area of the first story is equipped with steel sash for the full length of the building. All sash are 6 ft. 10⅜ in. high.

Each of the four sections of the house is equipped with an elevator having 9-ft. by 9-ft. doors and a platform measuring 9 ft. 4 in. by 17 ft. They are completely enclosed in 8-in. terra cotta wells. Each section is also equipped with two platform scales measuring 3 ft. 9 in. wide by 11 ft. long. One drop gangway bridge has been installed per section and provision has been made for the installation of a second. Freight will be handled by

The Deck of the Transfer Table—Two Electric Locomotives Showing Poling Arms in Two Positions



The Outer End of the Fireproof Warehouse During Construction

rolling doors for the full length of the building, there being two doors 12 ft. wide and 14 ft. high for each 24-ft. bay except at the firewalls. On the second floor there is one door of the same construction, 10 ft. wide by 11 ft. 6 in. high, to each 24 ft. bay except at each bay adjoining the firewalls, while the upper half of the intermediate space is given over to steel sash. On the platform side of the dock there is one rolling steel door 9 ft. wide by 9 ft. high to each 24-ft. panel with sash in the intermediate space. The second floor is arranged with steel means of cargo hoists carried from a steel superstructure over the dock side of the building. This cargo hoist superstructure is 65 ft. above the dock floor level and extends the full length of the building with a walkway in conjunction with it to facilitate the changing of unloading tackle. Two standard-gage tracks adjoin the rear of the building. Provision has been made for a battery charging room, as it is expected that electric tractors will be used in the operation of the freight house.

The open storage arrangement consists of four tracks

17 ft. center to center along the dock, adjoining which there is an open storage space 55 ft. wide and 1,100 ft. long. The two warehouse tracks are continued parallel with this storage space and are utilized when necessary in connection with it. An 18-ft. concrete highway about three-fourths of a mile long has been constructed, connecting the inshore end of the warehouse with Linden avenue, and paralleling the extended warehouse tracks in order that incoming and outgoing drayage may be handled.

Power Supply and Distribution

Electric power for lighting and for the operation of all machinery on the pier is purchased from the Public Service Corporation of New Jersey by the Bethlehem Steel Company. The Power Company meters are placed in a switch and meter house located at the eastern end of Linden avenue, about 1,800 ft. west of the foot of the pier. From the meter house the power is carried at 13,500 volts over a pole line to a sub-station owned and operated by the Bethlehem Steel Company, which is located on the pier about 1,000 ft. in from the pier head. In this sub-station the power is again metered, transformed and distributed for both steel company and railroad apparatus. All power used by the railroads is purchased from the steel company.

From the fixture pole outside the sub-station, the 13,000-volt power is brought through the sub-station wall in wall bushings and immediately inside the wall are located oxide film lightning arresters which may be disconnected from the line by air switches. The incoming lines also are connected through air switches to the main bus bar. The main bus bars are connected through oil-break switches to a cross bus behind the switchboard and from this cross bus the power passes through three more oil switches to three separate circuits. One of these circuits provides energy for operating two rotary converters in the sub-station, another is carried back along the transmission line to provide power for the Lehigh Valley warehouse and the air compressors located in the engine house near the foot of the pier and the third is connected through a bank of transformers to a large static condenser.

The static condenser is rated at 2,300 volts and was provided at the request of the power company for improving power factor.

The sub-station apparatus provides for four different kinds of power; namely, constant current of power for series lighting, 250-volt direct current for the operation of trains, locomotives and other power apparatus, 250-volt alternating current for the multiple lighting lines, and 220-volt alternating current for the operation of motors.

All of the large power transformers are located in a wire enclosure outside of the sub-station and a bank of smaller transformers for lighting are mounted on the fixture pole. After being carried through the switches, all the 13,500-volt power is carried again outside to the transformer and back a second time through bushings for connection to the static condenser and for the operation of two 500-kw., 250-volt direct current 6-phase, 60-cycle synchronous rotary converters. The 250-volt direct current power is used for the operation of the unloaders, the locomotives, and the transfer table. High peak loads which may be occasioned by the operation of the power apparatus would increase the rate at which power is paid for and for this reason, a fly-wheel generator set was installed to take care of sudden load peaks. This set consists of a 13-ton fly-wheel, connected to a 500 kw., 250-volt direct current generator, the speed of which varies from 1,000 to 1,200 r. p. m. A separate exciter mounted on the generator shaft provides field

The Interior of the Sub-station Is Well Arranged and Well Lighted

current for the generator and operates in conjunction with a regulator similar to a voltage regulator. The regulator causes the set to carry a portion of the load momentarily when the current requirement of the unloaders and locomotives is large.

Two series lighting transformers supply power for yard and track lighting. These transformers are rated at 24 kw., receive power at 220 volts and maintain a current of 6.6 amperes on the lighting circuit at a voltage which varies in accordance with the number of lamps in the circuit.

The locomotives were built by the General Electric Company and develop a draw bar pull of 12,500 lb. at a speed of eight miles an hour. The current is collected from two insulated conductor rails placed between the two running rails and protected by a covering of plank. The covering affords protection for those who must walk about on the track and also provides for protection against short circuits caused by ore falling on the track. The ore contains a high percentage of iron and is a very good conductor.

The enginehouse provides space for housing four locomotives and includes also a pit section on which a fifth may be placed for repairs. One room in the enginehouse is given over to two motor-driven air compressors which supply air through a 4-in. air line to the Claremont yard and also for local trains. The air compressors are Chicago Pneumatic Simplate valve compressors, size 15-9 x 19 and are driven by 125 hp., 60-cycle, 440-volt General Electric motors running at 860 r. p. m. The 440-volt alternating current power is provided from the 13,000-volt line through a bank of transformers mounted on a platform just outside of the enginehouse. The air pressure is maintained between certain limits by Cutler-Hammer full-automatic control apparatus. Cooling water for the air compressors is provided by a Gould Manufacturing Company centrifugal pump driven by a 3-hp., 60-cycle, 1,750 r. p. m. Westinghouse induction motor. A hot air furnace and a motor driven fan are used to supply heat for the enginehouse.

The Lehigh Valley warehouse is equipped with four motor operated elevators and is lighted by incandescent lamps most of which are mounted in R. L. M. type reflectors. A battery charging room has been provided in which machinery will be placed for charging batteries. Electric tractors will be used for handling freight and a number of charging receptacles are located just outside of the battery charging room from which the batteries on the tractors may be charged.

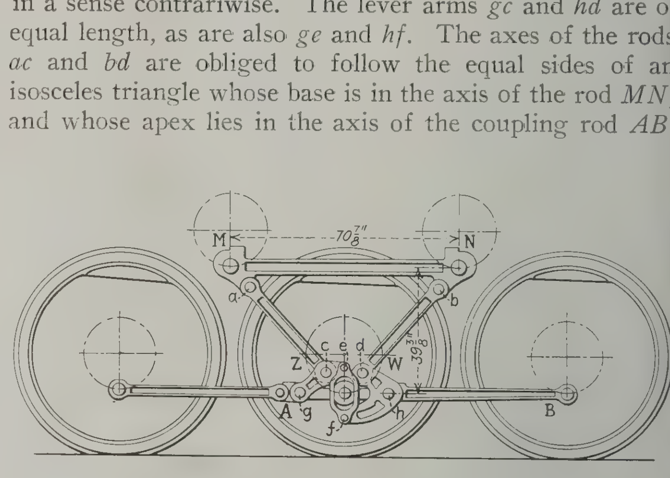
Articulated Connecting Rod for Electric Locomotives

By Reginald Gordon

In a recent issue of *Le Genie Civil* there appeared a description of a new design of connecting rod, or yoke for electric locomotives in passenger service on the Italian State Railways. These engines have two sets of three driving axles, one of which is shown in the illustration herewith. While the yoke connection between motor shafts and driver crank pins has been used for some time, the articulated or jointed design is new, and so far has been applied to only one locomotive.

A side rod *MN* connects the motor shaft cranks. Two oblique rods of equal length, *ac* and *bd* are each articulated at two points; at *a* and *b* on the rod *MN* and at the ends *c* and *d* of the links *Z* and *W*, thus allowing an oscillation around the points *g* and *h* situated on the axis of the coupling rod *AB*.

Another rod *ef*, connecting the links *Z* and *W* constrains them to move through sensibly equal angles, but in a sense contrariwise. The lever arms *gc* and *hd* are of equal length, as are also *ge* and *hf*. The axes of the rods *ac* and *bd* are obliged to follow the equal sides of an isosceles triangle whose base is in the axis of the rod *MN*, and whose apex lies in the axis of the coupling rod *AB*.



New Design of Articulated Yoke for Electric Locomotives

In its medium position, the axis of the link *ef* passes through the apex of this triangle.

The result of this arrangement is that the vertical component of the forces exerted by the rods is without effect on the wheels, while the horizontal component is transmitted integrally; any horizontal displacement of *MN* can produce no corresponding movement relative to *AB*. It is reported that this arrangement imparts great steadiness to the locomotive at high speeds and decreases the dynamic effect at the rail. The effects of centrifugal force are distributed between the rods connected to the motors and those that drive the wheels direct. On this account it was found possible to reduce the counterweights of the motor shaft cranks corresponding to the reduced balancing of the triangular yoke. Thus, on the locomotive in question, the counterweights of the motor cranks were each reduced 132¼ lb.; while those of the intermediate driving wheel were increased 220½ lb.

The locomotive is rated at 2,000 kw. capacity and can develop a maximum speed of 62½ miles an hour. During the year in which it has been in operation, it has run 18,750 miles without showing any wear on the pins of the articulated portions.

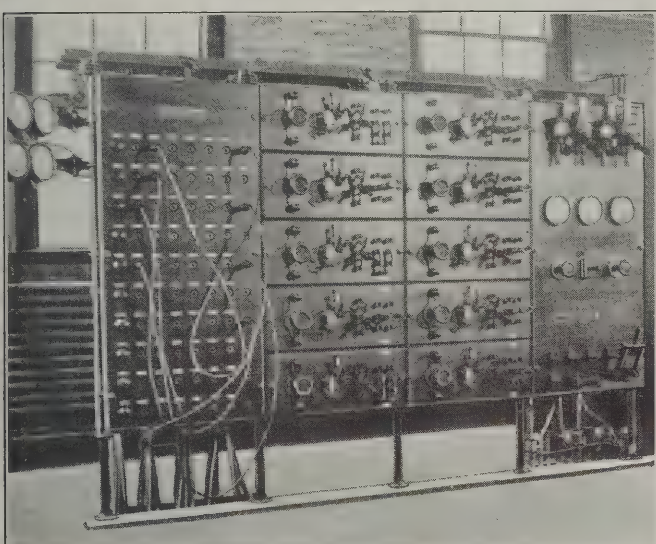
Synthetic Lumber Has Possibilities

Considerable work is being done at the present time by lumber interests with a view to utilizing more fully the product of the forests. Satisfactory methods have already been developed for the manufacture of composition lumber through the utilization of sawdust in combination with a glue binder. Although this work is as yet very much in the experimental stage, it seems possible, according to the Forest Products Laboratory, that developments within the next few years will make possible the marketing of composition lumber suitable for many purposes where ordinary lumber is now used.

Boston & Maine Installs Battery Charging Plant

Purchase of Ninety-eight New Electrically Lighted Cars Necessitates Additional Facilities

AT East Cambridge passenger yards, about a mile from the North Station at Boston, the Boston & Maine railroad have just completed the installation of a battery-charging plant. The recent purchase of ninety-eight electrically lighted cars is principally responsible for the construction of the new charging plant, although the old facilities had about reached the limit of service, having been in continuous service since 1909 and frequently under heavy overloads. The old charging equipment consisted of two mercury rectifier panels capable of charging five cars on a series circuit and it must be said that during the long life of this apparatus it had given remarkable service at an extremely low maintenance cost.



Close-Up View of Switchboard

The New Plant

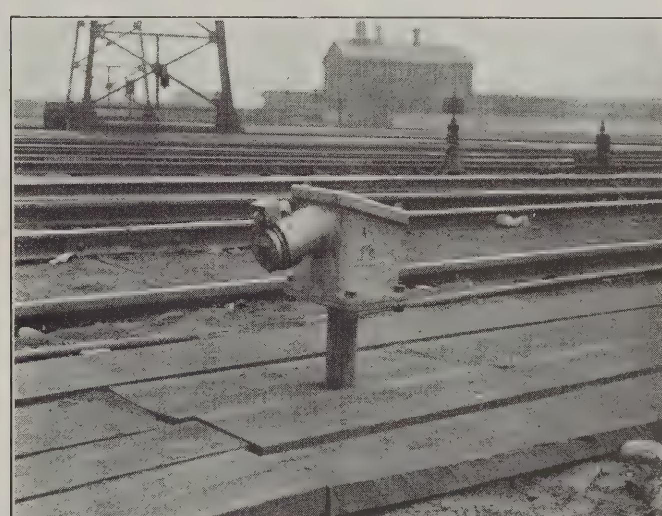
The new plant which now replaces the old rectifiers has a capacity sufficiently great to take care of the charging of ten cars at one time. The plant is situated between yards 3 and 4 and is laid out so as to serve all of yard 4 and part of yard 3, whereas the old plant was only capable of serving a portion of yard 4.

Power Supply

Electrical energy is brought to the plant on a 3-phase, 2,300-volt line from the main power station of the B. & M. at Minot street, Boston. For the greater part of the distance the line is overhead, the part between the Minot street station and Charlestown being already in existence prior to the construction of the new charging plant. A continuation of this existing line by means of a new submarine cable under Millers river and thence again on overhead construction to the plant, was required. The power enters the building on a lead-covered cable consisting of three No. 2 conductors with varnished cambric insulation which is rated at 3,000 volts. The cable is led to a General Electric F K 20 oil switch, which serves as a service switch. From this switch the power is fed to the bus bars of the motor generator sets.

Generating Equipment

For controlling the motors of the two motor generator sets two standard General Electric motor panels are provided. Each panel is equipped with a double throw oil switch for the starting and running of the motors. They are also each equipped with a field ammeter, a. c. ammeter and power factor indicator. General Electric motor generators are provided which consist of a 3-phase, 2,300-volt synchronous motor with a rating of 45 kw. or 56.3 kva. and an 85-volt flat compounded d. c. generator rated at 35 kw. Both sets are exactly alike so that the parts of one set may be used in the other should the necessity arise for this step. Each motor is fed from its panel through a lead-covered cable consisting of three No. 6 conductors insulated with varnished cambric and tested for 3,000 volts. The fields of these synchronous motors are designed to operate at full load on a d. c. potential of 70 volts, or 90 volts, or at any voltage between these values. The exciting current comes from the generator of the unit. The full load current capacity of the generators is 412 amperes each and each machine is protected by a General Electric type C P circuit breaker rated at 500 amperes, 600 volts. The circuit breakers give overload and reverse current protection. From the two generators the current is fed to a double generator panel, each machine feeding over two 750,000 circular mil, rubber-covered, lead-sheathed cables. All of the wire between the machines and switchboard is run in iron conduit under the concrete floor. The panel taking the generator output is also of the General Electric Company's construction. It is similar in design to the standard Edison three-wire panel, consisting of two double pole single throw knife switches which connect the positive from the positive machine to the positive bus and the negative from the

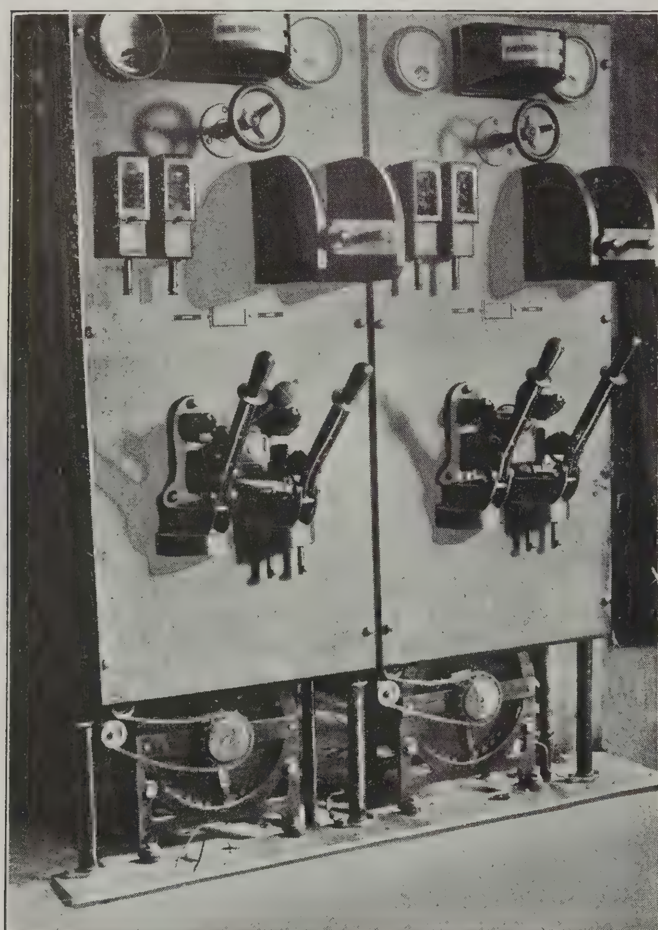


The Special Type Receptacle Designed for the New Installation

negative machine to the negative bus. The remaining terminal of each machine feeds through a circuit breaker onto a common bus bar, which in turn feeds through a single pole single throw knife switch to the neutral bus. A rheostat is provided on this panel for each generator. There is also a voltmeter on this panel which is connected to either machine by a voltage plug, and there are two ammeters which indicate the current coming from the two generators.

Charging Control Panels

The next two panels each consist of five sections for the independent control of ten cars which may be simultaneously on charge. Two of these sections are designed for charging cars at rates from 20 amperes up to 90 amperes. The other eight are arranged for charging at rates from 20 amperes up to 60 amperes. One 90-ampere



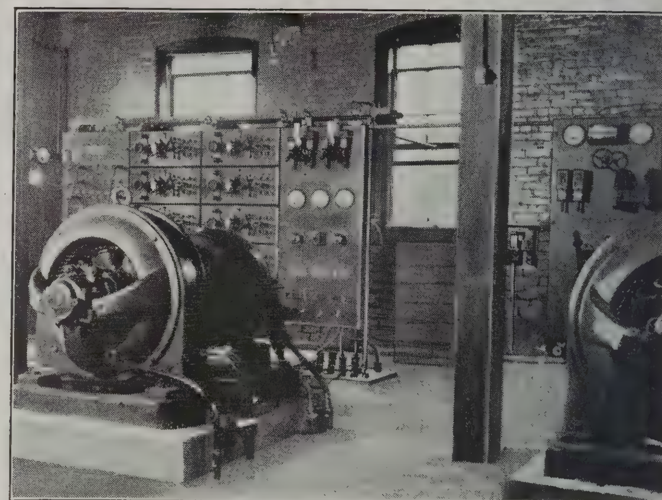
View of Power Panels

section and one of the 60-ampere sections are also arranged for discharging batteries.

Each section contains a two-pole double throw knife switch which, when thrown to the upper position, connects the panel to the positive bus, and when thrown to the lower position connects the panel to the negative bus. Next to this switch is a single-pole double throw meter switch which, when operated, connects the ammeter and voltmeter in circuit. From the meter switch the current goes to the circuit breaker, which is a G. E. Type C. G. of 100 ampere rating. After leaving this circuit breaker the current passes through an Allen Bradley carbon pile rheostat.

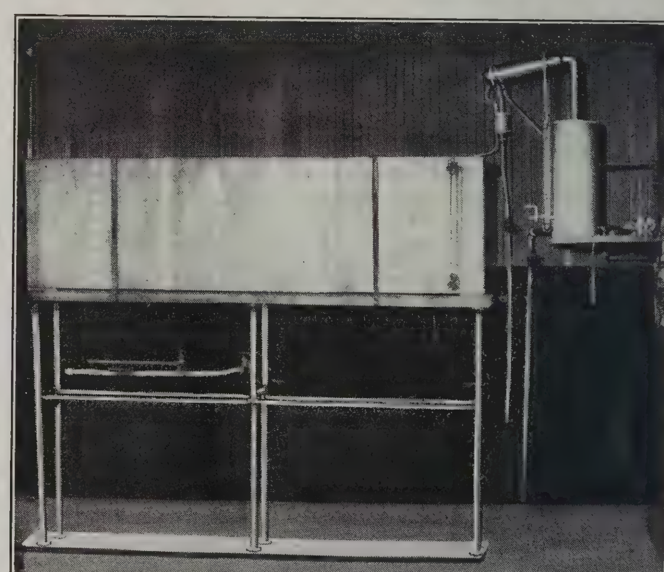
Distributing Panel

Each rheostat on these charging sections is connected to its individual charging receptacle. There are ten of these receptacles arranged in a vertical row at the extreme right hand side of the distributing panel. They are numbered from one to ten, corresponding with the numbers on the ten charging sections. Besides these ten



General View of Switchboard and Motor Generators

receptacles there are 60 distributing receptacles and also ten blank spaces for future additions. Each one of these outlets is a 100-ampere single-pole receptacle and is connected to a receptacle out in the yard, where the charging is done. At the left of the distributing panel, there are on the upper bracket two 100-ampere ammeters, one of which reads on positive charging circuits and the other

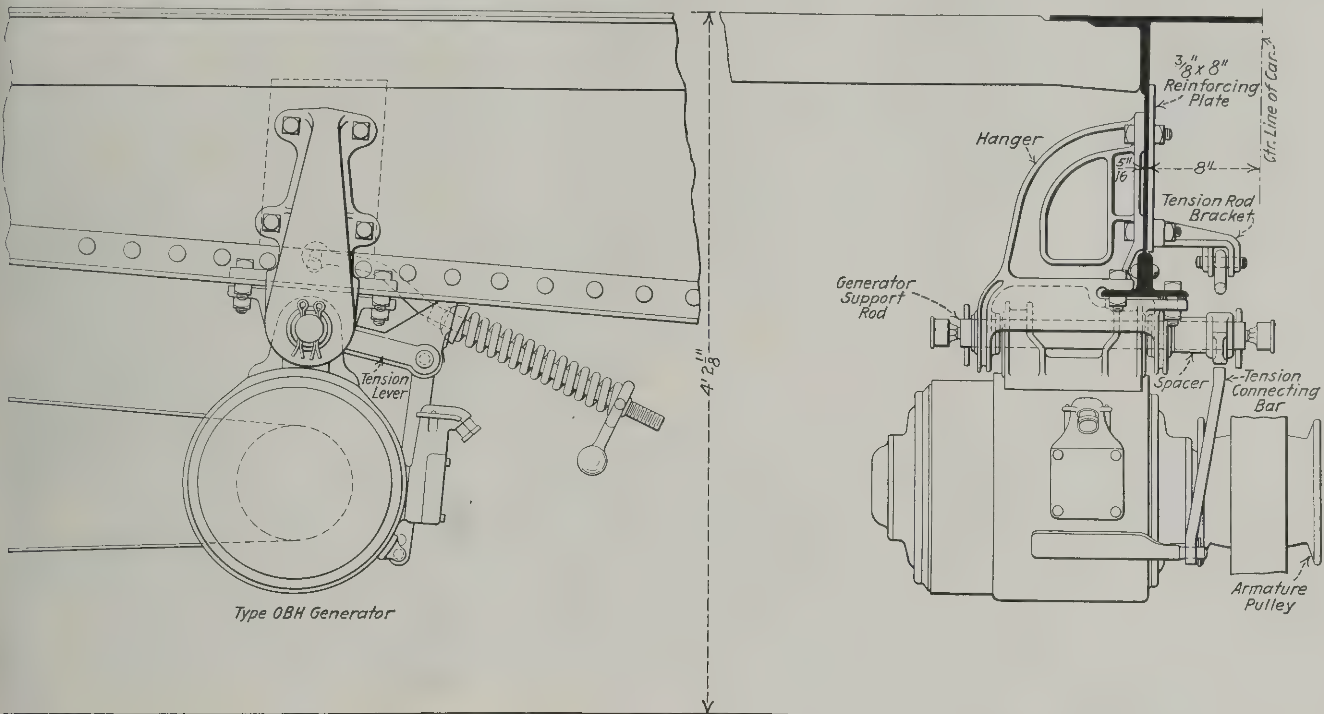


Water Distillation Apparatus

no negative charging circuits. On the lower bracket is a 150-ampere ammeter; zero center, which reads current of a battery on discharge and a zero center 150 voltmeter for reading the voltage of any battery on charge or discharge. These meters, as mentioned above, are put in circuit by the meter switch on the charging section.

There are no indicating lamps on the distributing panels but in their places, it is planned to install three telephones,

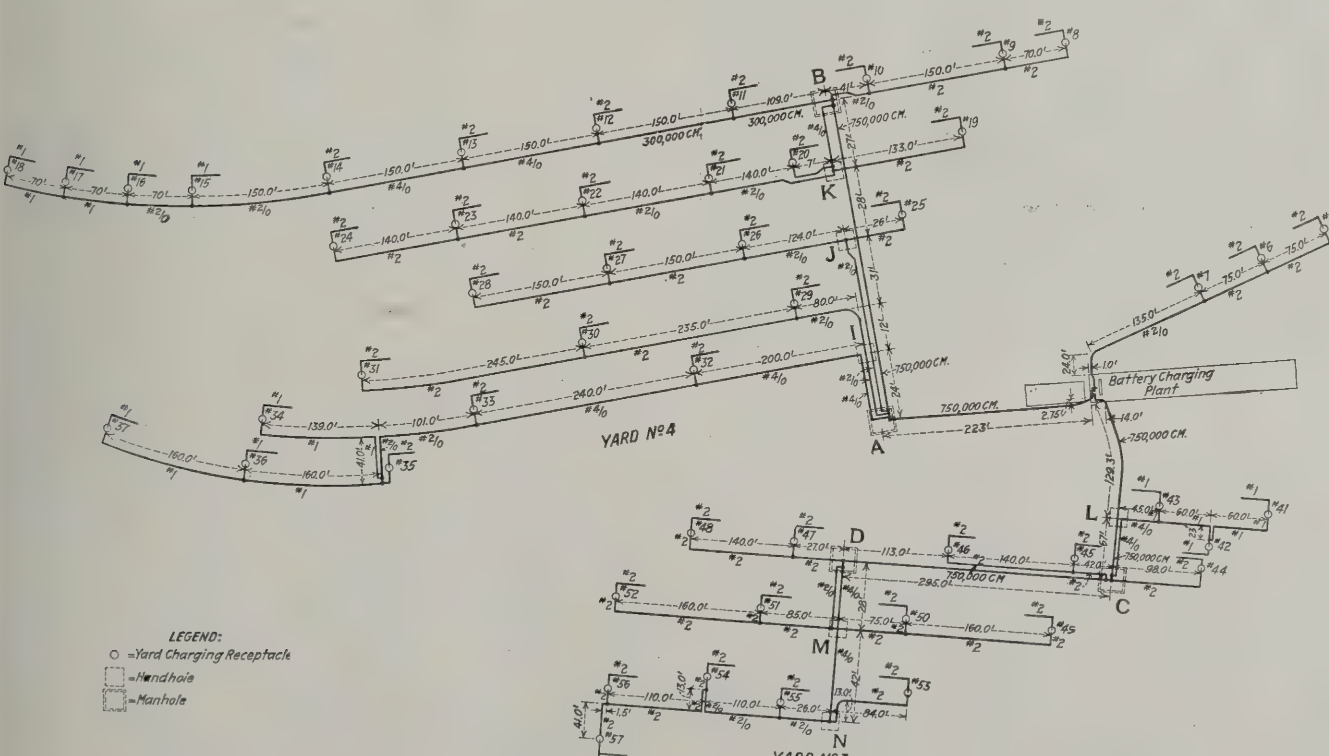
one in the charging station and one in each of the yards. When a car is in need of charging, it is connected to the nearest charging receptacle by the inspector, who then proceeds to the yard telephone and calls up the charging station, notifying the attendant that such a car is plugged inspector is made acquainted with the fact at once. In this way a large amount of time may be saved, inasmuch as yard men are not required to return to the station when a car is to be charged. The telephones can also be used by inspectors in emergency cases where material is



Line Drawing Showing Design of New Type of Body Hung Suspension Used by the Boston & Maine

to station No. — and requires four hours' charging at 60 amperes. The inspector remains at the telephone until the station attendant notifies him that the connection has been made. If an open or short circuit presents itself, the needed and train time is very limited. By calling the station, he can get in touch with the attendant, who can bring material to him while he is carrying on repairs.

From each of the receptacles on the distributing panel



Arrangement of Wiring in Yards Nos. 3 and 4 Giving the Sizes of Conductors Used and Length of Runs

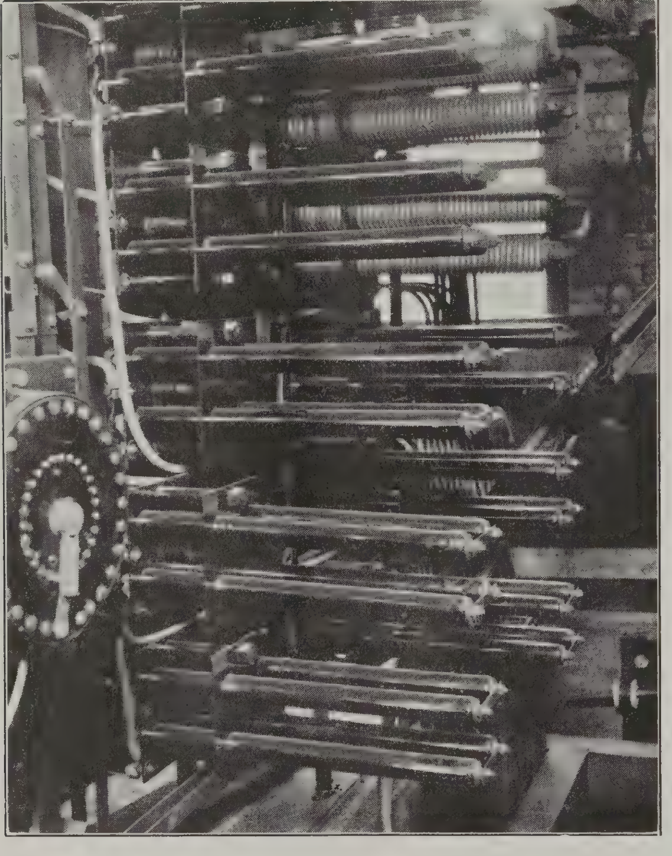
there is a rubber-insulated, lead-covered wire connecting to the corresponding receptacle out in the yard, all of the receptacles on the board being numbered from one to 60, those in the yard being similarly numbered.

Outside Wiring

These wires are all No. 2 or No. 1, the No. 1 being used for the more distant receptacles and for those in one section where the 90-ampere charging is to be done.

There is also a neutral feeder from the neutral bus out into the yard, starting at the switchboard with a 750,000 circular mil lead-covered cable and connected to one side of each yard receptacle. This neutral feeder reduces in size as the end of the line is approached until the last section is a No. 1 or No. 2 wire. Simplex Wire, supplied by F. M. Ferrin, Boston, is used throughout the installation.

Alternate receptacles are given even numbers and are connected so as to be charged between the positive bus and the neutral feeder. The remaining receptacles have odd numbers and are connected to be charged between the negative bus and the neutral. The whole arrangement is similar to the Edison three-wire system.

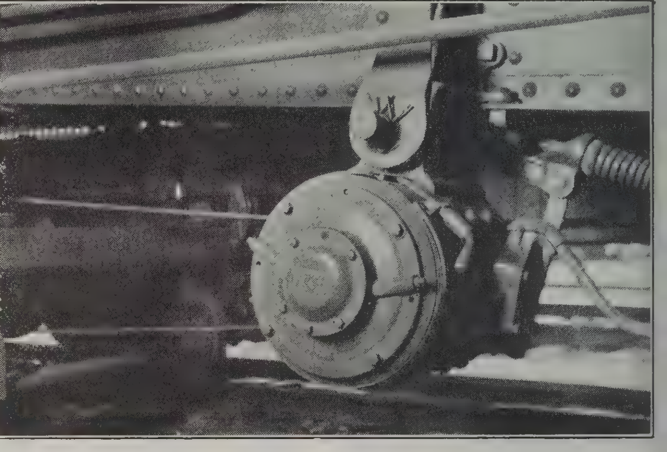


Rear View of Switchboard Showing Resistance Units Used in Charging

Construction Details

Approximately 42,000 ft. of wire was used in the battery-charging distribution system. The charging receptacles used out in the yard were made specially for this job by the A. & J. M. Anderson Co. The construction contains the standard M. C. B. receptacle but the box and housing are of special design. These yard receptacles are located along the platforms between the tracks. The center of each is approximately one foot above the platform. The main arteries of this distribution system consist of 3-in. fibre duct laid in concrete about three feet below the surface. This construction is used from the plant into each yard running generally at right angles to the tracks and crossing under all the tracks to be served, with either a hand-hole of a manhole between every second track. There are four 6 ft. by 4 ft. manholes and six hand-holes used in the construction. Both manholes and hand-holes are of reinforced waterproof concrete. From these manholes and hand-holes the distribution is run in iron conduits located under the boardwalks between the tracks.

Under each receptacle is an iron junction box in the pipe line. The lead cables, where spliced in the manholes or in the hand-holes, are sealed and covered with a lead sleeve. Where splices are made at recepatcles the lead sheaths are not broken in the junction boxes but are brought up through the pipe stem into the receptacle boxes and are there connected by means of a lug on each cable, the lugs being bolted together. The purpose of this construction is to avoid any breaks in the lead sheath at or below the ground line where they would be subject to damage by water in the pipe.



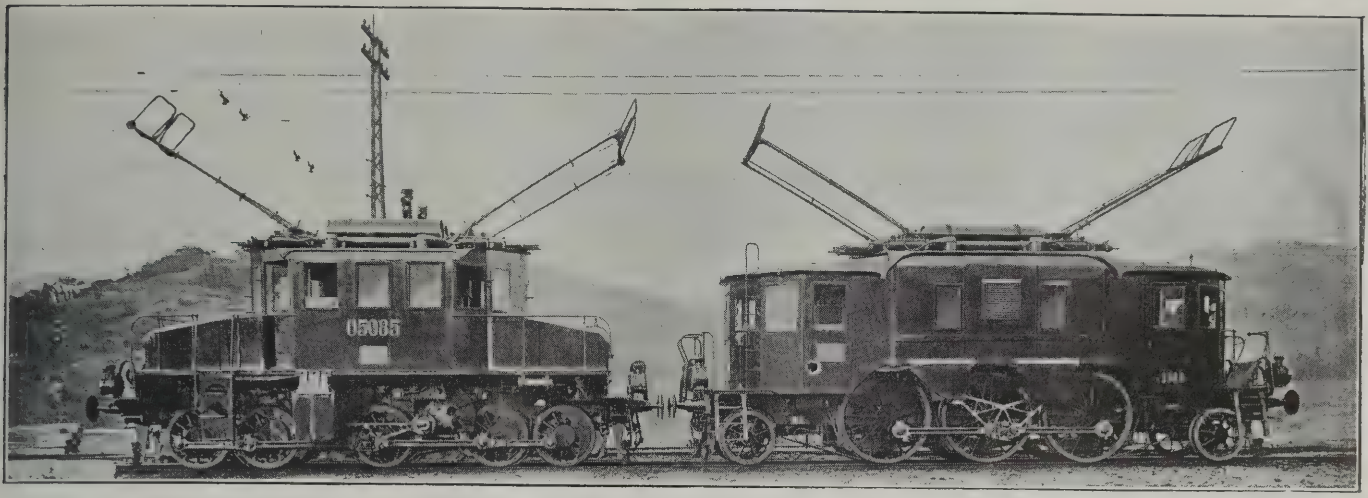
Showing the New Design of Body Suspension Used on the New Equipment

In the wire pit behind the switchboard where the distribution system begins split porcelain cable clamps are used to support the conductors. This construction has not been thought necessary in the outside manholes and regular galvanized iron adjustable cable racks are used instead.

Distilled Water Supply

An important adjunct to every battery-charging plant is a supply of distilled water for battery flushing and this feature has been taken care of by the installation of a Barnstead commercial steam type O still which has a capacity of five gallons per hour. The capacity of the tank into which the water flows from the sill is 80 gallons. The water is carried from the shop to the yard in a 50-gal. drum, mounted on wheels. This drum has been fitted with an Edison flushing outfit and an ordinary bicycle pump, which maintains the pressure necessary to force the water into the cells.

The Old Time Telegraphers and Historical Association convention will be held at Denver, Colo., on Thursday, Friday and Saturday, September 6, 7 and 8.



Italian Westinghouse Electric Locomotives Showing Rod Drive

Mechanical Parts of European Electric Locomotives

Clearances and Other Physical Limitations Greatly Affect the Design of Foreign Motive Power

By H. A. Kjelsberg
Railway Equipment Engineer, Westinghouse Electric & Mfg Company

FOR steam locomotives certain standards established during a long period of development apply practically all over the world. Not so for electric locomotives. The time for the development of this type of locomotive has been relatively short. There is also a great diversity in possible designs and arrangements. It is questionable if there will ever be such uniformity in design for electric locomotives as we have now for steam locomotives.

In a general way, one can divide electric locomotive mechanical designs into three classes. The first class is a further development of the electric street car (locomotives with axle-mounted motors), the second one is based on steam locomotive practice (rod drive), and the third one comprises all designs especially developed for electric locomotives (Westinghouse quill drive, Brown Boveri drive and others).

The second of these classes is most common in Europe and the third one is being developed there at the present time, while the first class, which is frequent in American practice, is scarce in Europe. This difference between European and American practice is due in the first place to the divergence of opinion among engineers, regarding the relative importance of the requirements to be met by the locomotives and, in the second place, to the difference in labor and operating conditions. A mechanical design is always a compromise between contradictory and conflicting requirements and this is especially true for electric locomotives:

The maximum axle load and the clearance diagram are probably the factors which have the greatest influence on the design of a locomotive and here is where the European engineer is much more limited than the American. In most countries the maximum axle load is only about half that permissible in the United States and the clearance diagrams are much smaller. For these reasons, the European engineer must be much more careful with weights and space than the American. The tendency to build every part as light as safety permits and as compact as possible can be seen in all European locomotives.

The space for this article is too limited to discuss all mechanical parts in detail, but the leading principles governing the design will be given in the following paragraphs.

Frames

Plate frames are used nearly exclusively in Europe for electric locomotives. Bar frames are not favored on account of their higher weight, less assurance of good material and the presence of secondary stresses, which may be dangerous and are always difficult to evaluate. The plates are reinforced by angles rivetted on, generally over the full length. Cross-ties are mostly box type steel castings. The pedestal jaws are steel castings and are bolted or rivetted to the frame. To save weight, the plates are cut out. The bumpers are either structural or steel castings.

Brakes

Both air brakes and vacuum brakes are used in Europe. There is generally an arrangement that the brake on the locomotive can be released separately while going down grade, so that only the train is braked. This is done to save locomotive tires and because in some countries the law requires that the couplings of the cars be always stretched and forbids holding the train with the locomotive alone. This law

makes regenerative braking by train weight in these countries impossible. If possible there are two brake shoes per wheel to avoid one-sided pressure on the journals.

Drive

Most European electric locomotives have rod drive, either direct or in connection with gears, both types with or without jackshaft. It would be too far reaching to describe the fifty or more different arrangements of rod drive that are in use; therefore only general characteristic will be given.

Direct drive is accomplished through scotch yokes, inclined rods or vertical rods. This drive requires large slow speed motors, but has the advantage that the motors are generally readily accessible.

Geared rod drive gives lighter motors, but the total difference in weight between a small motor with gear and a heavy slow speed motor without gears is generally inconsiderable. The experiences with both types of rod drive must have been generally satisfactory, because most of the railroads retain the once adopted type. Considerable troubles were experienced in the beginning with critical speeds, but since flexible gears and pinions are used the destructive consequences of vibrations have been practically eliminated.

It must be added in this connection, that European locomotives are generally very well maintained. The bearing clearances are kept within close limits and the center distances of the crank pin bearings are carefully adjusted. The magnitude of the vibrations at critical speed is a function of the clearances in the bearings and the accuracy of the center distances. If, by a correct flexibility in the gear or pinion, the critical speed is brought down to a low value where the inertia forces are small and at the same time bearing clearances are small and center distances exact, then there will be no difficulty on account of vibrations. In some cases it was possible to reduce the vibrations at the critical speed to such a degree, that they could be detected only by special measuring instruments.

Swedish Locomotive Showing Geared Rod Drive

Equalization

Three—and sometimes four-point suspension is used with single truck and articulated locomotives. Four-point suspension is possible because the track in Europe is generally smoother than it is in the United States. Side equalized trucks with the cab weight applied at two points, to get a balancing moment, are not used. In articulated locomotives the cab rests generally on two spherical center pins, one of them rigid and the other longitudinally movable, but laterally restricted. On account of the greater weight of the American locomotives it is very often impossible to support the cab at only one point per truck and therefore side equalization is necessary.

The spring hangers are in most cases adjustable to avoid shimming. Semi-elliptic springs are used but, in two—and four-wheel trucks, helical springs are often used in connection with semi-elliptic ones. All wearing parts in the equalization system are generally case-hardened.

General Features

In European designs of electric locomotives there is a tendency to raise the center of gravity to obtain better riding qualities and to reduce the vertical and lateral impact on the rails. For the same reason the dead weights are reduced. To make the entering of curves easier and to reduce flange wear the moment of inertia around the vertical axis should be as small as possible. This is accomplished by concentrating the heavy masses in the neighborhood of the vertical axis through the center of gravity.

Conclusions

In American locomotive design simplicity and easy maintenance become dominating factors under the pressure of the present labor conditions. In Europe where skilled labor is cheaper one is willing to sacrifice simplicity to get locomotives which are mechanically more perfect. The limitations in weight and less severe operating conditions exert an influence in the same direction. It can therefore be easily understood why the somewhat complicated rod drive has been preferred in Europe.

A Correction

We wish to call attention to an error on page 202 of the July, 1923, issue. Starting at the 10th line from the bottom of the page reads—"As it would require 437.5 ampere hours put into the battery to get 350 out next time, the ampere hour meter is so arranged that it will require the passage of 350 ampere hours to drive the hand back from 350 to 0."

These last lines should read—the ampere hour meter is so arranged that it will require the passage of 437.5 ampere hours to drive the hand back from 350 to 0.

The Union Pacific plans the construction of a new passenger station at Long Beach, Cal., and a water treating plant at Marysville, Kan.

Inspection Buildings of the N. Y., N. H. & H. at Stamford, Conn.

Electric Locomotive Maintenance on the New Haven

Inspections Made at Stamford on a Basis of 2,500 Miles Service—Heavy Repairs Made at Van Nest Shops

By H. T. Morris
Engineering Assistant, New York, New Haven & Hartford R. R.

As has been previously stated in another article,* the electric passenger locomotives of the New York, New Haven & Hartford Railroad are inspected at Stamford, Connecticut, on a basis of 2,500 miles of service. On account of train service using this point as a terminal, the shop is operated continuously, but regular inspection work is done during a day and night period only, except Sunday.

At the end of trips, all locomotives are looked over and any defects that may have been reported by the crew are corrected. These are usually light repairs, such as the replacement of a trolley shoe, but may cover switch group repairs, control repairs, renewal of brake shoes, defective piping, or in the case of the smaller locomotives, changing of a main motor. During the winter season, it is also necessary to fill oil and water tanks to take care of the train heating.

Three locomotives are inspected during the day, two being of the smaller type and one of the larger type of locomotive. At night, two of the smaller type are inspected.

The smaller locomotives which are the oldest in service, and use the gearless motors, have two classes of inspection, known as "light" and "heavy." The heavy inspection is each third inspection for a given locomotive, and at this time, the work done at light inspection is taken care of, but a longer time is allowed for this inspection and certain other things are done as well. The main motors are more carefully cleaned, the center bearings are lubricated, and several other items which are indicated in the inspection chart designated as "heavy inspection" items, are taken care of.

Locomotives for heavy inspection are so selected that one of the smaller type chosen for daylight inspection will be due for this work.

A chart showing the parts which must be cared for on a periodic basis is shown as Fig. 1. The items shown on this periodic inspection chart are checked as soon as it is known that a locomotive it to be inspected, and any of these items which fall due at this particular time, are taken care of, or if it is not possible, are listed for the next inspection.

The care of the oil circuit breakers on electric locomotives is somewhat different than on multiple unit equipment, it not being necessary to change the oil on account of the change from hot to cold weather. One grade of oil only is used in locomotive circuit breakers and this is allowed to remain in the circuit breaker, being inspected at the time the examination of the mechanism of the circuit breaker is due. If the oil at this time appears to be carbonized or has a greater amount of sediment, or presents a poorer general appearance than is customary, it is changed, otherwise, it is allowed to remain in the circuit breaker until a change is necessary.

The main motors are inspected in a manner similar to those on motor cars and brushes and brushholders renewed as may be necessary, and the bearings lubricated.

The switch groups are examined and all the usual wearing parts are changed as required, the items listed in the inspection chart being taken care of in addition, periodically.

The storage batteries are removed from the locomotives

*The maintenance of multiple unit cars on the New York, New Haven & Hartford R. R. was discussed in an article on page 163 of the June, 1923, issue of the *Railway Electrical Engineer*.

at each inspection and fully charged batteries are applied. A small motor generator set Fig. 2 having a sufficient capacity for charging five sets of batteries is kept in operation and as soon as batteries are removed, they are placed on charge. During an eight hour period, they are charged sufficiently to be used by the following inspection period. At the time the batteries are off the locomotives, such water is added as may be needed and in case the battery is defective in any way, it is forwarded to Van Nest Shop for repairs. The locomotive batteries supply

0301	0300	074	073	02	01	Period	Loco. No.	0301	0300	074	073	02	01	Period	Loco. No.
						6 mo	Control strainer.							6 mo	AC cir.brk.
						6 mo	Dead engine strainer.							6 mo	T.E.relay.
						6 mo	M.Res.check valve.							6 mo	AC trolley cyl.
						6 mo	Brake emer. relay.			X	X			6 mo	Ch.O.cyls.
						6 mo	Shoe down relay.							6 mo	Comp.crank cases.
						6 mo	Warning whistle.							2 mo	Compressor valves.
						3 mo	Foot push button boxes.							2 mo	Comp.air strainer.
						6 mo	DC O.L. trip.							3 mo	Interlock blocks.
						hvy insp	Feed valves.							3 mo	Canopy switches.
						3 mo	Magnet valves.							3 mo	Air gauges.
						HI or 2 mo	Insulation test.							12 mo	Brake cylinders.
						HI or 2 mo	Megger test.	X	X	X	X			6 mo	Brake cyl. double check.
o	o	o	o	o	o	Each insp	Wash,heat boiler.							6 mo	Distributing valve.
o	o	o	o	o	o	Each insp	Flues blown.							6 mo	Brake valves.
o	o	o	o	o	o	Each insp	Boiler safety valves.							6 mo	Governor.
														6 mo	Governor strainer.
						3 mo	Reverse cylinders.							6 mo	Signal valves.
				X	X	6 mo	Aux.devices governor.							6 mo	Signal strainer.
		X	X	X	X	2 mo	Compressor sw strainer.							6 mo	Air safety valves.

x - does not apply to this equipment.
o - during heating season only.

Fig. 1—Periodic Inspection Chart for Locomotives

power for the control system only, and are but one-half the capacity of those on multiple unit equipment. No charging devices are used on the locomotives except the battery charging relay, which opens the d.c. charging circuit in case power is cut off the a.c. side of the motor generator set.

The locomotive is given a complete mechanical inspection, brake shoes examined and renewed, journal boxes and other bearings packed and lubricated. On locomotives using the geared type motors with quill drive, the quill height is checked and if necessary the motor is adjusted to keep the quill properly concentric with the axle.

The air brake apparatus is adjusted and tested to see that it functions properly and such other work done as may be due for periodic inspection.

The pantagraph trolleys are tested out for operation, the shoes examined for wear, and the spring tension measured both going up and coming down. Fig. 3 shows a view of the roofs of several locomotives undergoing inspection at which time these adjustments are made. The high tension cable connecting the two trolleys together with the supporting insulators for the cables, hose, and trolleys themselves, are given a megger test periodically. This test tends to eliminate defective parts such as cracked porcelains before they bring about a failure in service due to moisture or other causes.

Each locomotive is equipped with two motor driven blowers and compressors. These motors are cleaned, brushes and brushholders examined and renewed, and bearings lubricated. Ball bearings are used on most of the blower motors and are grease lubricated.

At the completion of the inspection, the sequence of switches and the action of the auxiliary motors is tried out to see that all parts function properly.

Electric Freight and Switch Locomotives

The inspection of freight and switching equipment is done at Van Nest electric shops, two locomotives undergoing such inspection being shown in Fig. 4. These locomotives are also inspected on a 2,500-mile basis, two being inspected each working day, within an eight-hour period.

Before going into the shop, the locomotive roof, main motors and other equipment are blown out with compressed air, as these locomotives use a large volume of cooling air for the electrical equipment, and operate with windows opened practically all the time, which accumulates fairly large quantities of dust. On coming into the shop, all parts are inspected in the same general manner as on passenger equipment, a number of items being cared

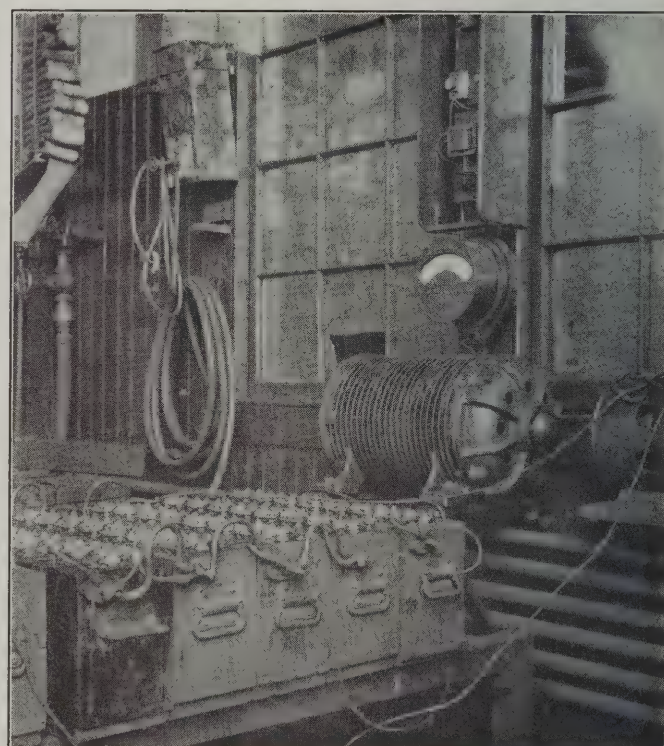


Fig. 2—Motor Generator Set for Charging Batteries for Locomotives

for on a periodic basis, as shown on the periodic inspection chart, Fig. 5.

All these locomotives use a quill spring drive and all springs must be inspected and retaining bolts checked for tightness at each inspection. This is being done by the two men shown in the illustration. The quill height is checked for concentricity and adjusted if necessary.

Other mechanical parts are inspected, the draft gear requiring more repairs on freight and switching equipment than with passenger. In case of trouble, the entire draft rigging is removed and another unit applied.

As Van Nest shops is the point where all major repairs are taken care of, in case any parts are found defective,

they are changed while the locomotive is undergoing inspection, if possible. In case it is found that such items as wheels or main motors must be changed, the inspection is completed with the exception of the part to be changed and the locomotive is then taken to another portion of the shop where such work is done. This usually requires an additional day to make such a change, Van Nest shop not working on a continuous basis.

As the freight and switching locomotives are designed for a.c. service only, the number of pieces of control apparatus are very few and are relatively easy to keep in repair. Therefore, there is no heavy inspection of such parts, defects usually being found at the regular inspection, and additional work is not done except at periods of general overhaul.

General Overhaul Work

Passenger Equipment.—Passenger locomotives are given a general overhaul on a basis of 200,000 miles. At this time the locomotive cab is lifted from the trucks and supported in such a way that work can be done both inside and outside the cab.

All riveted parts are checked and if found to be loose, are again riveted properly and the trucks are completely dismantled and re-built with new parts or such repaired portions as can be again used. The cab sheets are replaced if found to be rusted through and the cab is painted inside and outside.

Air tanks are removed and given a hydrostatic hammer test and the date of such test stencilled on each one.

The motors that have been taken from the trucks are dismantled and new bearings applied, fields and armatures cleaned and the commutators turned if necessary.

On the small locomotives using the gearless motors, all parts are worked very close to their rating or above it and on this class the switching equipment is entirely removed from the cab, and is dismantled, new insulation applied, if necessary, and again re-built. In order to do this work on this class of locomotives, a spare set of switch groups is maintained, so that as the old equipment is removed, a new set can be set in place almost immediately without waiting for the time which it will be required to overhaul it. Fig. 6 shows one of these older types of switch groups in the assembly department where the overhaul work is done, practically completed and again ready for installation.

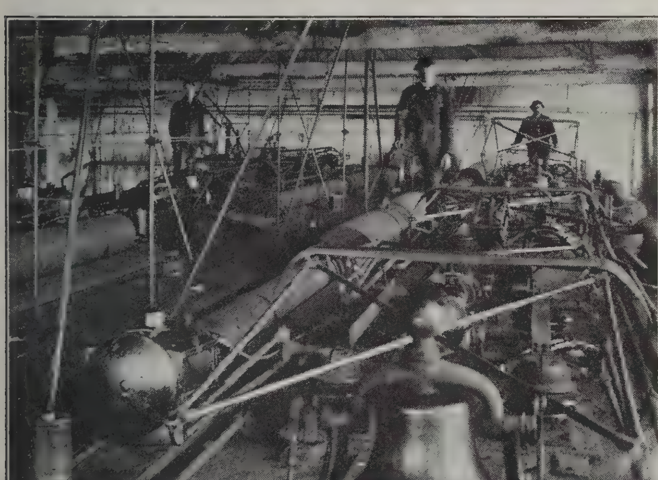


Fig. 3—Inspecting Pantagraphs at Stamford

On the later types of passenger locomotives, the equipment has been more liberally designed and it has not been necessary to completely remove all apparatus from the cab. The working units themselves, such as the switches, cylinders and valve magnets, reversers, and auxiliary magnets are removed and overhauled and again installed for service.

Fig. 4—Locomotive Inspection at Van Nest Shops

The working parts of the air brake equipment are removed and repaired, cleaned and tested, and again replaced. The dates applied at the overhaul period now become the basis for future periodic inspection.

	0201	0200			077	076	Period	Loco. No.
							6 mo	AC cir.brk.
							6 mo	T.E.Relay.
							12 mo	AC trolley cyls.
							6 mo	Reverser cylinders.
							6 mo	Signal valves.
							6 mo	Signal strainers.
							6 mo	Safety valves.
							12 mo	Brake cylinders.
							3 mo	Air gauges.
							6 mo	Distributing valve.
							12 mo	Brake valves.
							6 mo	Governor.
							6 mo	Governor strainer.
							6 mo	Control strainer.
							6 mo	Dead engine strainer.
							6 mo	Feed valves.
							6 mo	Foot push button bxs.
							6 mo	Warning whistles.

Fig. 5—Periodic Inspection Chart Freight and Switching Locomotives

Truck Overhaul.—At times between the period of general overhaul a locomotive may require truck repairs or it may develop undesirable riding qualities. If so, the cab is lifted from the trucks and they are overhauled and such repairs made on other parts as may be necessary.

The electrical equipment aside from the main motors is not disturbed at this time.

Freight and Switcher Equipment.—On the freight and switcher equipment which is overhauled on a basis of 100,000 miles, it has not been found necessary to completely remove all apparatus during general overhaul. Only the working parts such as switches, cylinders and magnet valves, drum type reversers, auxiliary magnets, and the blower and compressor motors are themselves removed, and these units are replaced by similar ones which have been repaired and put in first class condition.

Fig. 6—Switch Group Being Overhauled in the Assembly Department at Van Nest Shops

Repairs to the cab itself, painting, hydrostatic test of reservoirs, and similar work is done, as on passenger equipment.

The air brake apparatus is removed, cleaned and tested at this time, so that the date when the locomotive is released from general overhaul can be used as a basis for establishing the next periodic inspection.

The trucks are overhauled in the same manner as on passenger equipment and main motors are re-built as may be found necessary.

Each overhauled locomotive, after the equipment is all assembled again, and the parts connected up for service, or after motor changes at Van Nest shops, is given a short test under its own power including the individual operation of main and auxiliary motors to see that it functions properly, both on a.c. and d.c. for passenger and on a.c. only for other equipment. After releasing from general overhaul, a locomotive is restricted in service for a few days to see that hot bearings and other defects do not develop, after which it is released for general service.

A list of changes and improvements for each class of locomotives is kept, and an attempt is made to do this work at the time of general overhaul. Many of these changes relate to improvement in layout or capacity of the equipment and after they are completed, greatly assist in the work of inspection and maintenance.

The passenger locomotives of the smaller type do not have sufficient capacity to handle singly, trains of the weight operated in most cases, and are usually double-headed. This requires three nine point jumpers which are given a test every six months for broken wires, short circuits, and other defects, at Van Nest shop. As on multiple unit equipment, a designating color is used to show the period of last inspection.

On freight equipment, two twelve point jumpers are required, and these are inspected on an annual basis, as the jumpers are somewhat longer and do not have the continued rubbing against each other that occurs with the short ones in passenger service.

The Chicago Rock Island & Pacific has adopted new regulations for dealing with freight claims. Text books are furnished trainmen and agents containing instructions for proper handling of freight, with a list of the usual causes of loss and damage arranged alphabetically. The freight loss and damage work is now under the Freight Claim Department. A complete record of causes of freight damage will be kept with respect to every train and every station as a means of fixing responsibility for damage.

Peking Station of the Peking-Hankow Line

Train Control Installations

PURSUANT to order number 13413 of the Interstate Commerce Commission directing 49 railways named therein to install automatic train stop or train control devices upon designated portions of their roads, a number of the railroads have selected the devices which they wish to install as trial or permanent installations. The order requires that the installations be completed by January 1, 1925. Since the order was originally issued the commission has authorized changes in the territories on a few of the roads.

The railroads listed in the order, the limits of the territory specified, and the devices selected to date follow:

A. T. & S. F.—Chicago to Shopton, Iowa, 234.6 mi. double track.—Union Switch & Signal Company's continuous induction now being installed on about 104 mi.

A. C. L.—Acca, Va., to South Rocky Mt., N. C., 114.6 mi. double track.—General Railway Signal Company's tapered control.

B. & O.—Baltimore, Md., to Washington, D. C., 36.3 mi. double track.—General Railway Signal Company's tapered control. Test installation, Baltimore to Relay, 9 mi., 6 engines.

B. & A.—Springfield, Mass., to Albany, N. Y., 101 mi. double track.—Devices not selected. This company is joining with the N. Y. C. on an installation between Toledo, Ohio, and Detroit, Mich.

B. & M.—Boston, Mass., to Greenfield, 105.6 mi. double track.—Union Switch & Signal Company's continuous induction; 13.7 mi. to be installed at once.

B. R. & P.—Rochester, N. Y., to Ashford, 12 mi. double track, 82 mi. single track.—General Railway Signal Company's tapered control. Trial installation on 15 mi. being made.

C. R. R. of N. J.—Red Bank, N. J., to Winslow Jct., 65.9 mi. single track.—Devices not selected.

C. & O.—Gordonsville, Va., to Staunton, 61 mi. single track.—American Train Control Company. Already installed on 21 mi., Gordonsville, Va., to Charlottesville, and is being extended to Staunton.

C. & A.—Chicago, Ill., to Bloomington, 126.6 mi. double track.—National Safety Appliance Company. Test installation, 14 mi.—Lexington, Ill., to Normal—being made.

C. & E. I.—Yard Center, Ill., to Danville, 105.4 mi. double track.—Miller Train Control Corporation. Installation now in service.

C. & E.—Marion, O., to Huntington, Ind., 126.6 mi. double track.—Devices not selected.

C. & N. W.—Boone, Ia., to Council Bluffs, 149 mi. double track.—General Railway Signal Company—tapered control. A 16-mi. test installation is being made between West Chicago, Ill., and Elgin, not on selected territory.

C. B. & Q.—Creston, Ia., to Omaha, Neb., 44.3 mi. single track, 63.4 mi. double track.—Federal Signal Company, induction. Test installation of about 6 mi. to be made first.

C. I. & L.—Bloomington, Ind., to New Albany, 97.1 mi. single track.—First section to be installed between Orleans and New Albany, 56.5 mi.—Device not selected.

C. M. & St. P.—Bridge Switch, Minn., to Hastings, 108.1 mi. double track.—Devices not selected.

C. R. I. & P.—Blue Island, Ill., to Rock Island, 165.4 mi. double track.—Regan Safety Devices Company. Present installation Blue Island, Ill., to Joliet to be extended.

C., St. P., M. & O.—St. James, Minn., to Le Mars, Ia., 122.6 mi. single track.— This company is joining with the C. & N. W. in tests of the General Railway Signal Company's device. Devices not selected.

C. N. O. & T. P.—Ludlow, Ky., to Somerset, 78 mi. single track, 78.5 mi. double track.—General Railway Signal Company, tapered speed control. Test of intermittent induction type to be made between Ludlow and Williamstown, Ky., 35.2 mi.

C. C. C. & St. L.—Indianapolis, Ind., to Mattoon, Ill., 128.3 mi. single track. This company is joining with the N. Y. C. in an installation between Detroit and Toledo. Devices not selected.

D. & H.—Whitehall, N. Y., to Rouses Point, 113 mi. single track.—Federal continuous induction type. A test installation between Colonie and Albany, 3.51 mi., is to be made.

D., L. & W.—Elmira, N. Y., to Buffalo, 146 mi. double track.—Device not selected.

ERIE.—Port Jervis, N. Y., to Susquehanna, Pa., 104.2 mi. double track.—Device not selected.

G. H. & S. A.—San Antonio, Tex., to Houston, 200 mi. single track, 10 mi. double track.—National Safety Appliance Company. Test installation of 51 mi. to be made first.

G. N.—Minot, N. D., to Williston, 121 mi. single track.—Device not selected.

I. C.—Champaign, Ill., to Centralia, 124.7 mi. double track.—Device not selected.

K. C. S.—Met. Jct., Kansas City, Mo., to Pittsburgh, Kan., 121 mi. single track.—Device not selected.

L. V.—Newark, N. J., to Easton, Pa., 34.6 mi. double track, 24.8 mi. three track, 6.2 mi. four track.—Device not selected.

L. I.—Territory not decided. This company is a party to tests of Union Switch & Signal Company's device on the Lewiston branch of the Pennsylvania.

L & N.—Corbin, Ky., to Etowah, Tenn., 165 mi. single track.—Device not selected.

M. C.—Detroit, Mich., to Jackson, 79 mi. double track.—This company is joining with N. Y. C. on a test installation between Detroit and Toledo.

M. P.—Kansas City, Mo., to Council Grove, 150.1 mi. single track.—National Safety Appliance Company. Short test installation to be made first.

N. Y. C.—Albany, N. Y., to Syracuse, 10.5 mi. double track, 129.2 mi. four track, 8.2 mi. five track.—Bids have been received and submitted to the Interstate Commerce Commission for an installation between Detroit and Toledo.

N. Y. C. & St. L.—Chicago to Ft. Wayne, Ind., 128.4 mi. single track, 14.2 mi. double track.—Device not selected.

N. Y., N. H. & H.—Air Line Jct., Conn., to Springfield, Mass., 62 mi. double track.—Union Switch & Signal Company, continuous induction. Test installation Air Line Jct. to Wallingford, 10.5 mi.

N. & W.—No decision. This road is a party to tests being made of Union Switch & Signal Company's device on Lewiston Branch of Pennsylvania.

N. P.—Mandan, N. D., to Dickinson, 109.3 mi. single track.—Device not selected.

O. W. R. R. & N.—East Portland, Ore., to Pendleton, 193.6 mi. single track, 23.1 mi. double track.—Device not selected.

PENNSYLVANIA SYSTEM.—Territory not decided. Union Switch & Signal Company, continuous induction test installation being made, Sunbury, Pa., to Lewistown, 50 mi. Not on the territory named in the order.

P. M.—Application for change in territory has been made.—Union Switch & Signal Company, continuous induction.

P. & R.—Camden, N. J., to Atlantic City, 55.5 mi. double track.—Union Switch & Signal Company, continuous induction.

P. & L. E.—Pittsburgh, Pa., to Youngstown, O., 18.9 mi. double track, 1.7 mi. three track, 45.5 mi. four track.—Joining with N. Y. C. in the installation from Detroit to Toledo.

P. C. C. & St. L.—Territory not selected. This company is a party to the tests being made of the Union Switch & Signal Company's device on the Lewistown branch of the Pennsylvania.

R. F. & P.—Richmond, Va., to Washington, D. C., 116.5 mi. double track.—Device not selected.

St. L.-S. F.—Springfield, Mo., to Monett, 39.7 mi. single track 4 mi. double track.—National Safety Appliance Company. Test installation Nichols Jct., Mo., to Brookline.

SOUTHERN.—Spencer, N. C., to Greenville, S. C., 153 mi. double track.—General Railway Signal Company's tapered control. This company is joining with the C. N. O. & T. P. in a test installation.

S. P.—Oakland, Cal., to Tracy, via Port Costa, 51 mi. single track, 24 mi. double track.—National Safety Appliance Company. Test installation Hayward to Halvern now in service, not on selected territory.

U. P.—Territory not selected.—Union Switch & Signal Company's continuous induction. Test installation of about 5 mi. to be made at once.

W. J. & S.—Territory not selected. This road is a party to tests of Union Switch & Signal Company's device being made on the Lewistown branch of the Pennsylvania.

W. M.—Hagerstown, Md., to Cumberland, 80 mi. single track.—Device not selected.

Mike Has Trouble with the Belt

A car was reported to Mike one morning as lying in the station "dark." On receiving the information Mike dashed madly to the station, and finding that the car had a dry cell procured a pail of water and a voltmeter, and began to pour water into the cell very slowly. The porter inside the car, seeing the lights come up gradually, stuck his head out the window, and seeing Mike pouring water into the cell, said, "You all poor dat juice in dar by the bucket full?" And Mike replied, "No, that would be too much, we quit when the voltmeter reads 32 volts."

Mike never knew how dumb he really was until he walked around for an hour one day looking for the head electrician to explain to him why the new belt he put on would not get tight when he screwed up the tension wrenches. The head electrician showed him that he had forgotten to remove the block he had put in to hold the machine up. He kicked the block out only to find that the belt was under the break beam instead of over it as it should be.

After he had straightened out the belt and replaced it, the boss told him to try the polechanger before tightening the tension; he did this and after doing so, he found the machine stuck so that he had to take the belt off again.

After putting a new P. E. bearing in and replacing the belt, the boss came along just in time to ask him again to try the polechanger. Again it did not work and upon opening up the other end of the machine he found the armature open and consequently the belt had to come off again.

Mike changed the armature and put the belt on. He had tightened it up in good shape, when he noticed that one head cap screw in the P. E. was missing and he went to the storeroom to get a new one. While he was at the storeroom, the car was moved far enough to move the axle pulley half way around so that when replacing the missing screw he noticed that one-quarter section of the axle pulley was missing and he had to take the belt off for the fourth time to repair the axle pulley.

By this time Mike's good humor began to leave him for after repairing the axle pulley he found that the new belt was too short and he had to put in a splice.

He had become so used to tightening up the machine that he tightened it up again and went up to motor it. Placing his first two fingers on top of the auto-switch, leaf-contact and thumb below, he started to motor the machine, the belt tight. The switch smashed his finger tips and the generator fuse blew in his face. Mike was getting madder and madder when the foreman came along and asked him what the trouble was.

The inside man also came along about then and asked Mike to help him find the open circuit on the center light, which he did. After they examined all the switches, fixtures and lamps they began to work back along the circuit and when they reached the distributing panel they breathed a deep sigh of relief, knowing that they were close to the open—which they were for they found the fuse blown.

Mike, however, had a lot of confidence in himself. He was going to Philadelphia the other day and in leaving Pennsylvania Station, New York, he looked in one of the regulators to see how it was working. A passenger noticed him there and asked what the thing was for. Mike said this is what runs the train by regeneration—when the train gets going fast this regulator switches the generator on to the battery which runs it as a motor to drive the car wheels through a belt, the engine on the head end—then being driven by the rest of the train regenerates back into the third rail.

On the night he came back the conductor asked him to look at the car ahead as the lights were flickering terribly. Mike, upon examining the regulator noticed the field arm pumping badly. He pulled out the generator fuse and receiving the thanks and congratulation from the porter and conductor.

One of Mike's cars was reported regularly as arriving at the station from the yard with the belt off the axle pulley, or missing. This finally began to get Mike's goat so he started to ride this car to the station. About half way to the station and just having passed a bad curve, the train stopped for a few seconds and Mike got off to look at the belt, it was off the axle pulley and riding around the axle. He could not understand it but about that time the train started again and he jumped on intending to replace the belt in the station. On arriving at the station he got out to put the belt on and found it already on and in perfect condition. Mike vowed right then and there to quit drinking moonshine.

The boys pulled a joke on Mike the other day. He was going to take out an armature when some of them held the auto-switch closed exciting the generator field. Mike would pull, cuss and sweat and pull some more until he finally gave it up. One of the other boys came along then and lifted out the armature quite easily in front of Mike. Mike has not given up hope, however, of becoming a Pullman electrical wizard and still contends that there should be somebody there to close those automatic switches when the generator gets to going fast enough.

Impurities in Storage Battery Electrolytes

The importance of obtaining information concerning the action of impurities in storage battery electrolytes arises from the detrimental effects which many of them produce on the operating characteristics and life of the storage battery. Such information is necessary as a basis for the preparation of specifications covering sulphuric acid for use in batteries. A new method of measuring the rate of sulphation of storage battery plates was recently devised at the Bureau of Standards. The same method and apparatus have been employed in the present investigation with some modifications, and the effects of small amounts of iron, manganese, platinum, and copper have been determined. It was found that the presence of 1 part in 10,000,000 of platinum in the electrolyte increases the local action at the negative plates 50 per cent; the effect of copper is much less, while the effect of iron is of unusual interest because of its accelerating action at the negative plates. Manganese deposits upon the positive plates in the form of manganese dioxide which covers the active material, closes the pores, and causes a large amount of charging current to be wasted as gas. Work is being extended to include the effect of other impurities.—*A. I. E. E. Proceedings.*

Motor Drive for Cylinder Boring Mill

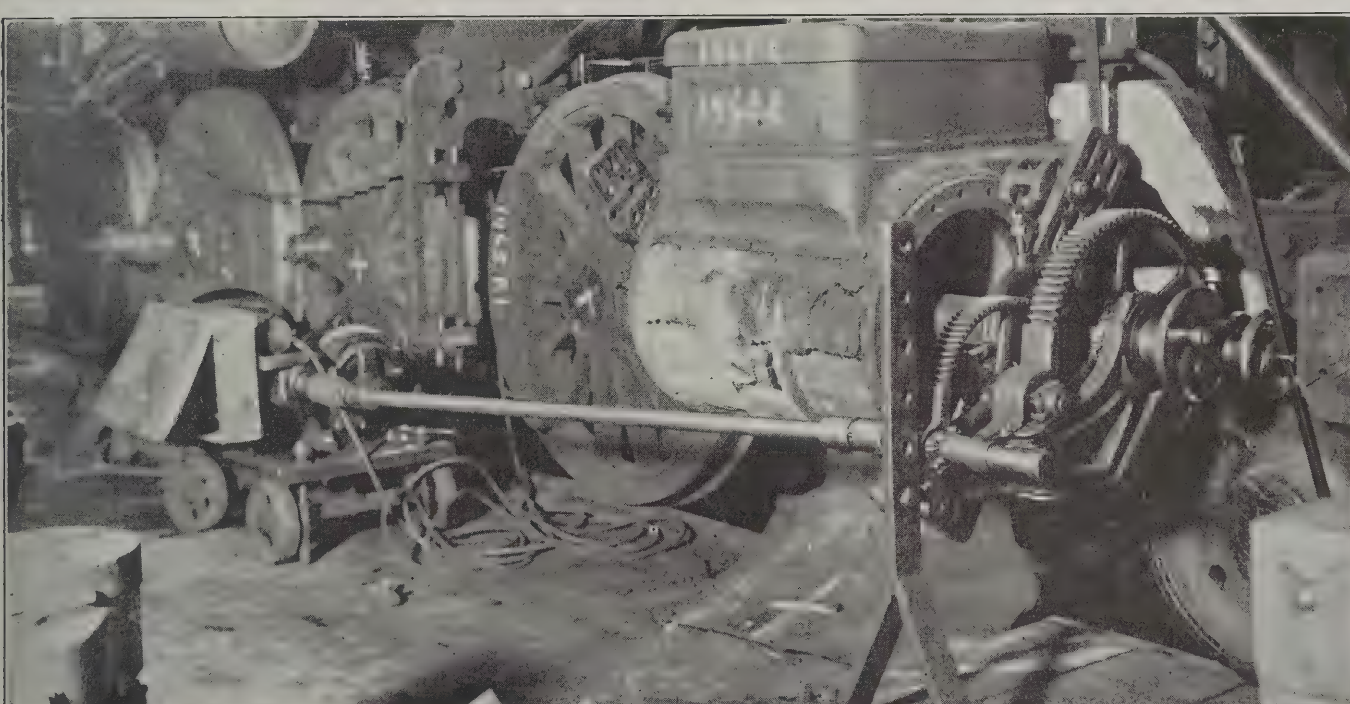
A portable motor drive for a locomotive cylinder boring mill has been built in the Susquehanna shops of the Erie Railroad which has supplanted and improved upon the air motor formerly used for driving the machine.

The drive consists of a 3-hp., 220-volt, 3-phase, 60-cycle Westinghouse motor with a full load speed of 870 r. p. m. mounted on a four-wheeled truck. The motor is back geared and drives a 1¼-in. shaft which is about seven feet long, through the single reduction gear. The ratio of the pinion to the gear is four to one. There are two universal joints in the driving shaft so that it is not necessary to aline the motor accurately. The boring mill is set up and bolted to the locomotive cylinder, the driving motor is wheeled to a position near the rear of the cylinder and the shaft is connected. Two ¾-in. bolts run through holes in the deck of the cart, with nuts top and bottom, when turned down, lift the cart off its rear wheels. These bolts act as legs and steady the cart and the nuts hold the bolts in position.

The motor is controlled by a double throw, three pole knife switch mounted in a sheet metal cabinet with a hinged cover. The switch is fused at one end and the motor is started by throwing it directly on the line after which the switch is thrown to the other position which connects the running fuses in the circuit. The cover of the cabinet is hinged at the top so that the cover is normally closed.

Power is brought to the switch through flexible three conductor cable and ready connection and disconnection is provided by a Crouse-Hinds type R. S. condulet mounted on the truck and type S O plugs on both ends of the cable. A number of type R. S. condulets are mounted at intervals on the supporting columns of the shop and these are supplied with power by three No. 4 cables carried in 1-in. conduit.

The drive is of course economical in the cost of power required, it is easy to set up, and readily portable. That the tool is dependable and satisfactory is indicated by the fact that the men who use it state it is steady in operation and never causes the cutting tool to chatter.



The Drive is Readily Portable and is Highly Satisfactory and Economical in Operation

Watch the Dry Cells

During the last four years the Illinois Central System purchased 262,910 dry cells at a cost of $71,156.45. This represents an expense of $58.13 for each working day. The annual cost of these dry cells, capitalized at 6 per cent, equals the interest on an investment of $296,487.

Much of this expense is due to lack of care in handling and using the cells. Few users of dry cells realize that they require considerable care and that large numbers are ruined or badly damaged through improper handling and storage, even before they are placed in use.

Dry cells should never be stored with the terminal end down, nor should the cells be laid on the side; they should always be stored with the bottom down. In receiving dry cells for storage, those in charge should mark the date of receipt on each cell, issuing in the order of receipt, the oldest one first.

Dry cells should be stored in a dry, cool place and never near radiators or steam pipes, as excessive heat will wear the cells out more quickly than continuous use in actual service. On the other hand, they should never be allowed to freeze.

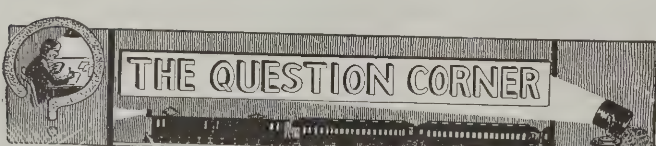
Old, weak cells should never be used in the same battery with fresh cells, as the strength and life of the battery will be only that of the weakest cell.

In using an ammeter or battery tester, touch the terminals firmly, but remove the contact as quickly as the reading is obtained. Prolonged contact will short-circuit the cell and run down its strength quickly.

Many motor car operators have the erroneous idea that seven or eight dry cells are necessary to provide an efficient spark. Four or five cells are sufficient for any motor car battery and will provide just as good a spark as eight cells, with about three times the life of the eight-cell battery. The five-cell battery has an added advantage in the fact that it will not burn out the coils and contact point so quickly as one with a greater number of cells, thus actually furnishing more reliable ignition.—*Illinois Central Magazine.*

Polarity of Train Lines

Connect one terminal of a test lamp on the regulator panel to positive battery; touch left contact on connector head (facing end of car) with the other end. If you get a light the head is not reversed as the lamp will be connected from the positive battery to negative battery. The positive side of the head can be tested in the same way. To test the head on the opposite end of the car, use the neutral wire or run a wire through the car.



Answers to Questions

1. *How much current does a 60-volt, 25-watt lamp require when operated on a 60-volt circuit?*
2. *How much current does a 30-volt, 25-watt lamp require operated on a 30-volt circuit?*
3. *What is the resistance of a 25-watt, 30-volt car lighting lamp and of a 25-watt, 60-volt car lighting lamp?*
4. *What current will flow through 60-volt, 25-watt car lighting lamp when connected across a 30-volt axle generator as a pilot lamp?*
5. *Suppose a 30-volt, 25-watt lamp and 50-volt, 25-watt lamp are connected in a series across a 60-volt circuit, how much current will flow and what is the total resistance?*

* * *

Other Methods for Determining Polarity of Generator Fields

In testing the polarity of generator field coils by means of a compass, I have not found that this instrument can always be relied upon. Moreover, there are not many compasses to be found in railroad yards and I doubt very much if electricians in general are using the string and needle method.

I have found the following method of making this test to be very satisfactory and can be made with tools that are always available. In making the test, it is necessary to remove the armature, brush rigging and housings, so that the pole pieces are exposed and handy for testing. Remembering that fields of like polarity do not attract each other, span the gap between two adjacent poles with a cap wrench or pliers. If they stick when applied, between any two pole pieces, the polarity is correct. If they do not stick, it is an indication that the two poles are either both north poles or both south poles and the connections must be changed until the pliers or wrench will stick. Continue testing poles 1 and 2, 2 and 3, 3 and 4, and 4 and 1. If the wrench sticks on all poles as indicated, the generator is correctly connected. In making the above test, of course, current must be passing through the field coils.—T. S.

* * *

In answer to the June question—there are several ways of testing the polarity of generator fields. In order to be able to test out the various electrical apparatus in use today, it is very important that one should have a working knowledge of electricity. I should suggest to anyone working around electrical apparatus to learn the principles of electricity from a good book or correspondence course. Even if one does not want to be an electrical engineer, it is always useful to know the how and why about it. Oerstead discovered, about one hundred years ago, that a magnet tends to set itself at right angles to a wire carrying an electric current, and that the way in which the needle turns, depends upon the position of the wire that carries the current (above or below the needle). It also depends upon the direction in which the current flows through the wire. To keep these movements in mind the following rule can be used. Maxwell's corkscrew rule is a handy rule and a good alibi for anyone carrying a corkscrew. According to this rule the direction of the current and that of the resulting magnetic force are in the same relation to each other as are the forward travel and rotation of an ordinary corkscrew. In other words, when you are pulling the cork out, if the current is assumed to be flowing from the handle to the point of the corkscrew, the end of the cork inside the bottle will be a north pole, see Fig. 1. Fig. 2 shows another rule for finding the polarity, this is called the right hand rule. If the coil is held in the right hand so that the fingers point in the direction of the current flowing in the wires (the current flowing from the positive to the negative) the thumb will point to the north pole. Therefore, knowing the direction in which the field coils are wound and knowing the direction of the current,

the polarity is seen at once. If the armature is not in place, the poles can be tested by passing a small current through them, and test each pole with a compass. Fig. 3 shows how the coils are connected on several types of two-pole and four-pole generators. If all the field coils are wound in the same direction in the four-pole machine, they are connected as shown. Starting with No. 1 the end of this coil is connected to the end of No. 2, and the start of No. 2 connected to the start of No. 3, end of No. 3 connected to end of No. 4. This gives the correct polarity. —A. H. M.

* * *

Resistance and Current Consumption of 30-Volt and 60-Volt Car Lighting Lamps

In answer to the question concerning the current consumption and resistance of lamps which appeared in the June issue, the following is offered:

1. Using the formula of Ohm's law

Current = watts ÷ volts
or
Current = 25 ÷ 60 = .417 ampere

2. The same formula applies in problem No. 2

Current = 25 ÷ 30 = .834 ampere

3. This is really two problems for it is first necessary to find the current that such a lamp will take. This, however, can be obtained from problem 2.

Current = 25 ÷ 30 = .834 ampere

Knowing the current, the resistance may be found from the formula

Resistance = volts ÷ current
or
Resistance = 30 ÷ .834 = 35.9 ohms

In the same way the resistance of the 25-watt, 60-volt lamp will be found to be equal to 143.6 ohms.

4. In problem 3, we found that a 60-volt, 25-watt lamp had a resistance of 143.6 ohms. The current flowing in such a lamp when connected to a 30-volt circuit as a pilot lamp would then be found from the formula

Current = volts ÷ resistance
or
Current = 34 ÷ 143.6 = .236 ampere

5. In this problem we must find the resistance of the 50-volt, 25-watt lamp first. To do this it is necessary to find the current flowing from the formula

Current = watts ÷ volts
or
Current = 25 ÷ 50 = ½ ampere

Then from the formula

Resistance = volts ÷ current

we find

Resistance = 50 ÷ ½ = 100 ohms

From problem 3, the resistance of the 30-volt, 25-watt lamp may be obtained so that the present problem resolves itself into the addition of the resistance of the two lamps in series which is

35.9 + 100 = 135.9 ohms

If these two lamps are connected in series across a 60-volt circuit, the current flowing will be given by formula

Current = volts ÷ resistance
or
Current = 60 ÷ 135.9 = .441 ampere

It will be seen that all of these problems may be solved by the application of the various forms of Ohm's law.

Note—The above calculations are based on the assumption that the resistance of the lamp filament is constant, that is, that the filament has zero temperature coefficient, which of course is not strictly correct. See letter to Editor on page 228.

* * *

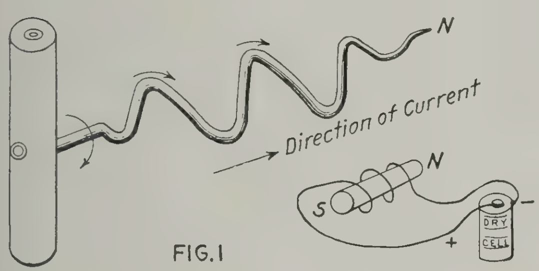


FIG. 1

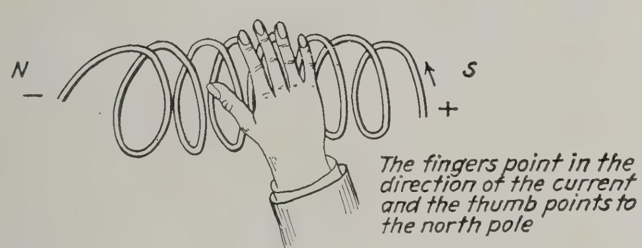
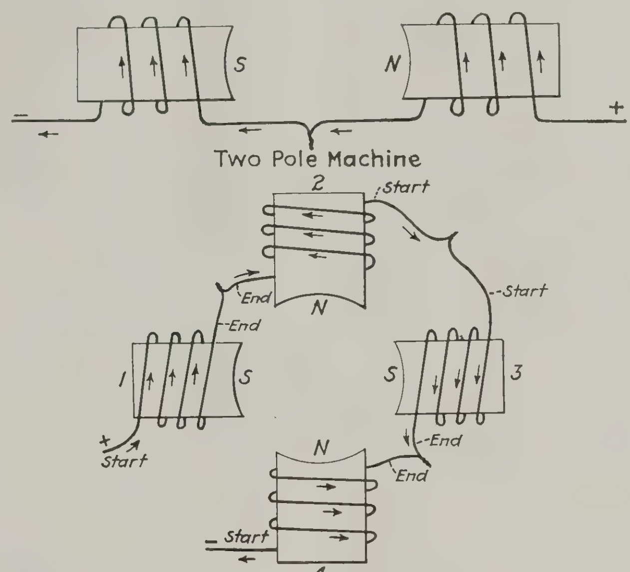


FIG. 2



Four Pole Machine
FIG. 3

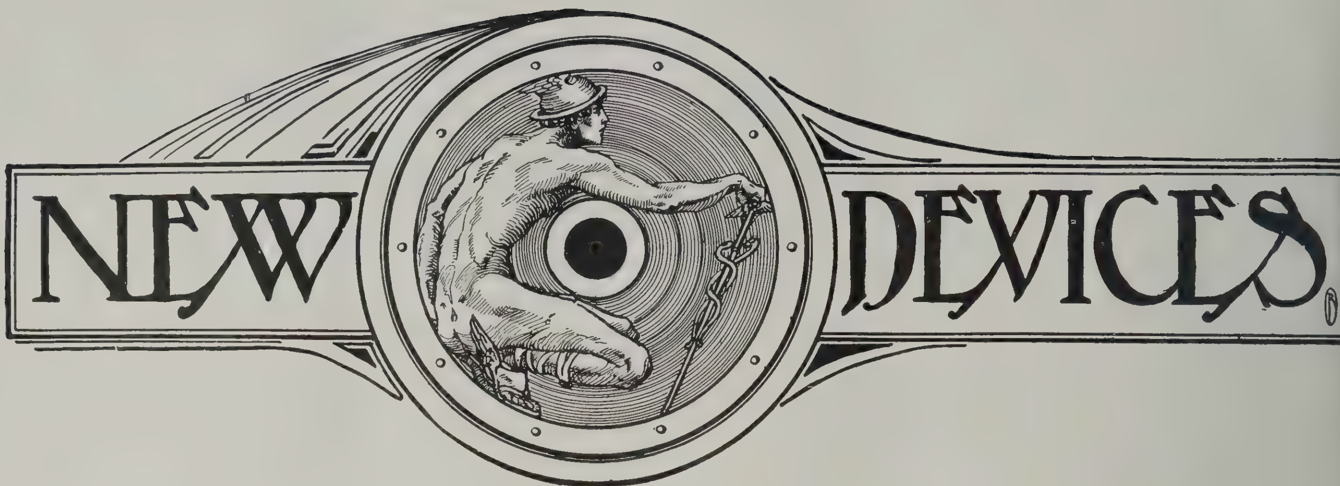
Diagrams Showing Relation of Polarity and Direction of Current

Questions for August

1. *What is the highest temperature that is considered safe for the operation of lead storage batteries?—J. C.*

2. *What is meant by the temperature coefficient of resistance?—R. F.*

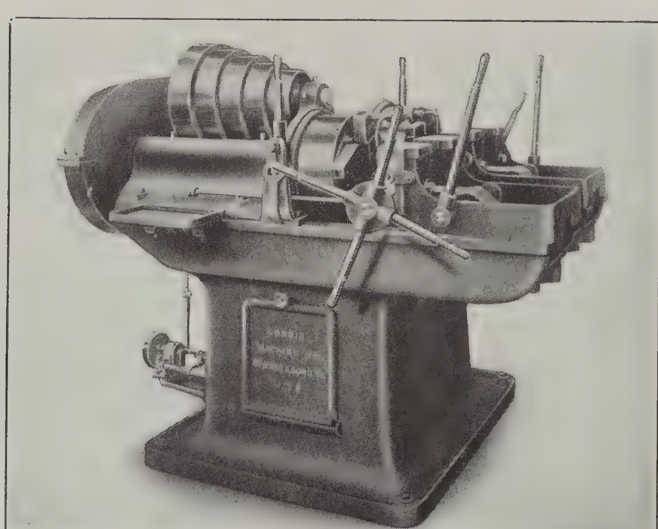
3. *It is desired to run a 10 hp. pumping motor from a 110-volt circuit, the source of power being 2,000 ft. away from the motor. If a line drop of 10 per cent is allowed what size wire will be required?—R. E.*



Pipe Machines with Internally Tripped Die Heads

The Landis Machine Company, Waynesboro, Pa., is now making an improved type of pipe and nipple-threading machine with internally tripped die head. This type of head automatically insures a uniform length of thread on nipples and eliminates the necessity of gaging each nipple by hand. The new machine will thread, ream and chamfer both pipe and nipples.

The drawing illustrates the principles of operation of the Landis internally tripped die head. The knurled collar *A* and the clamping rod *C* are integral. The clamping rod *C* is threaded on one end which screws into a tapped hole in the shank of the reamer *K*. Knurled collar *B* is integral with the tube *D* which is threaded

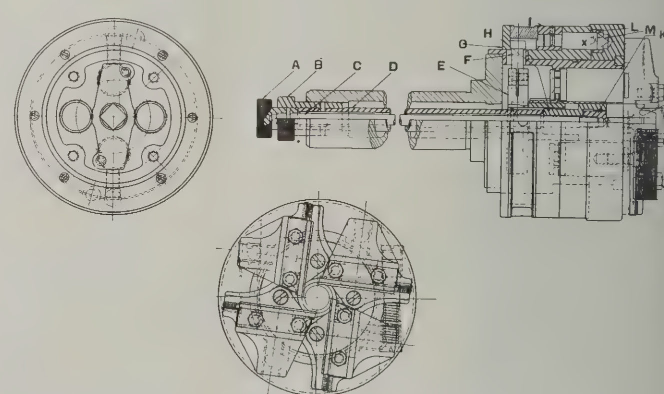


Landis Pipe and Nipple Threading Machine

on one end and screws into the spider *E*. Spider *E* has a square hole through it and furthermore is tapped part of the way to fit tube *D*. This gives thread bearings on the four sides of the square hole. The reaming portion of the hole in the spider is plain, to afford a bearing for the driver *H*. Driver *H* has a square hole in the end to receive the shank of the reamer *K*.

To set the reamer to the correct position, the knurled collar *K* is drawn tightly by hand. This clamps together in one unit, tube *D*, driver *H* and reamer *K*. The surface *Y* on reamer *K* has no cutting edge. Therefore, as the nipple is being threaded and the end begins to bear on reamer *K*, the units *D* and *H* transmit the pressure to spider *E*. Through the medium of pins *F* in spider *E*, rings *G* and *I* are carried backward for a distance *X* or until pin *M* is disengaged from bushing *L*. The full opening movement is then completed by a spring in the adjusting ring.

To adjust reamer *K* longitudinally, the clamping rod *C* is unscrewed by turning knurled collar *A* to the left.



Drawing Showing Construction of the Internally Tripped Die Heads

Collar *B* is adjusted to right or left for either forward or backward movement depending upon the length of the thread to be cut.

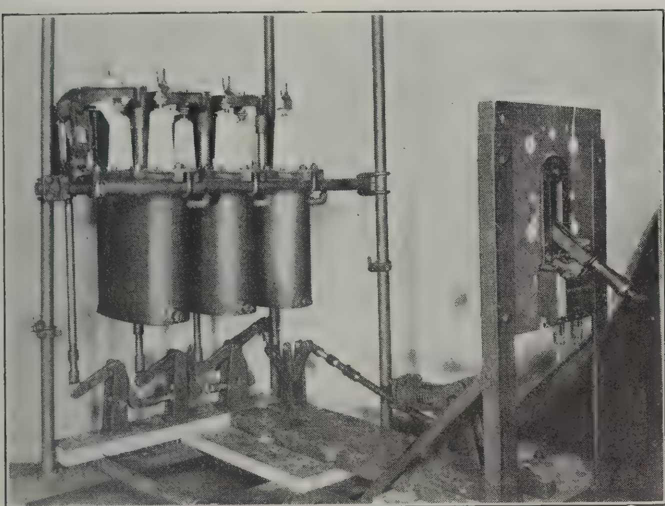
This new Landis internally tripped die head and machine, employing Landis high speed steel chasers and chamfering reamers, is made in the ½ in., 1¼ in., 2 in. and 4 in. sizes and in both single and double spindle types.

New Oil Circuit Breaker

A new oil circuit breaker, the type F-33, in capacities of 400, 600 and 800 amperes at 15,000 volts, has been placed on the market by the Westinghouse Electric & Manufacturing Company. This breaker has an interrupting capacity of 1900 amperes at its rated voltage and is applicable wherever a breaker of that capacity is needed. It is made in the remote control form only to

conform to the recommendations of the Electric Power Club oil circuit breaker standard practice rules limiting the service of panel mounting breakers to voltages not exceeding 2500. A separate pole per frame construction makes it particularly applicable wherever it is desired to have the phases isolated.

The type F-33 breakers are supplied for either manual or electrical automatic or non-automatic operation and in single, two, three or four pole units. Each pole unit is entirely separate with its own frame, mechanism and tank. The heavy cast-iron framework is arranged for



Type F-33 Manually Operated Circuit Breaker

either wall or pipe mounting. The mechanism of the breaker is provided with a toggle which permits the breaker to be adapted readily for upward, downward, or horizontal pull without the use of any additional material. A highly efficient form of wedge and finger contact is used with an auxiliary arcing contact on the moving element. The stationary contact is so shaped and located that different portions of the same contact surface act as the main current-carrying contact and as the arcing contact, thus preventing arcing on the main contact surface. The sheet steel tanks have all seams lap-welded and are lined with micarta.

The electric operating mechanism has a solenoid with a three inch diameter core and consists of a cast-iron frame with spaces for closing and trip coils. The moving core of the closing solenoid pulls the main lever down to the closed position, where it is latched, and the trip coil disengages the latch. The mechanism is provided with springs to make the breaker open more rapidly. A two-pole, double-throw auxiliary switch is used for cutting out trip coil currents and controlling indicating lamps.

Headlight for Track Inspection

An inspection car type of headlight in which is used the patented Golden Glow reflector has been placed on the market by the Electric Service Supplies Co., Philadelphia, New York and Chicago. These headlights, as illustrated, are designed to be suspended from the platform of inspection or private cars over the center of each rail as shown by diagram. By training each beam along its rail a very complete illumination is secured of the entire road bed. They are fitted with extra front door ring having a heavy wire screen to protect the front glass and reflector from breakage. This outer screen door can be opened inde-

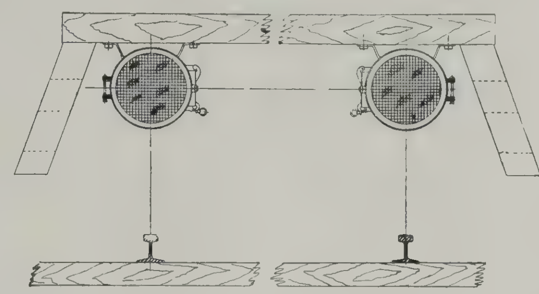
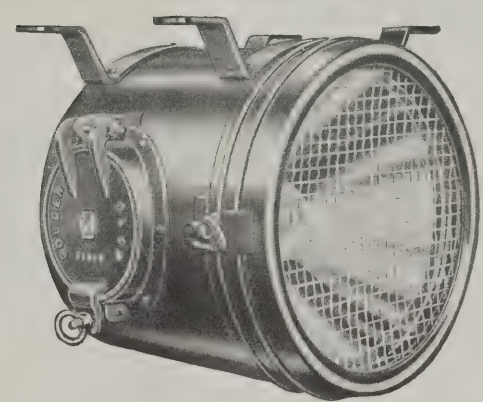


Diagram Showing Installation

pendently of the inner door, thus permitting cleaning the front glass.

The method of suspending headlights from the plat-



Type LFF—128 Inspection Headlight

form has been found more desirable because the eyes of the observer do not need to penetrate the beam to such an extent as when installed on the roof or railing of the car.

Heavy Duty Extension Cable Reel

The heavy-duty Reelite, recently developed by the Appleton Electric Company, Chicago, is a self-contained device for paying out and automatically retrieving electric conductors for power and light. It is especially adapted for machinery requiring a varying length of cable. This will permit operation of the machinery at any distance within a radius equal to the length of cable contained in the reel. An important advantage of this device is the protection to the cable which is thereby afforded a long life.

Among the machines with which this device can be used may be listed cranes, dredges, magnets, electric motor buckets, etc. It can also be used extensively in foundries, blacksmith, machine and car shops, and welding shops.

The device is furnished without brackets but with 1-in. male-threaded hubs so that it is easily adaptable to any requirement. The power cable is connected to it by means of heavy brushes operating on commutators. The wire is connected to the commutators, eliminating wear and tear.

The heavy-duty Reelite can be furnished in various widths, all of the same diameter and with two or three wire commutators, as may be required. In ordering, it is necessary to specify the amperage and voltage so that proper commutators and brushes will be installed.

General News Section

The French Battery & Carbon Company has moved its Chicago office to 11 South Desplaines street.

The Detroit Terminal Company has awarded a contract to the Roberts & Schaefer Company, Chicago, for the installation of an electric cinder handling plant at Detroit, Mich.

The Southern Pacific has authorized the construction of a locomotive assembly shop at Los Angeles, Cal., to cost approximately $500,000. Construction of the new building will start in the fall.

The Pacific Electric is constructing approximately six miles of new tracks in its freight yards at Los Angeles, Cal. The construction of new yard offices is included in the project, the total cost of which will be approximately $198,000.

The New York, Chicago & St. Louis has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of a 700-ton reinforced concrete coaling station with automatic elevating equipment, at Conneaut, Ohio.

The Michigan Central has awarded a contract to the Ellington Miller Company, Chicago, for the construction of an 8-stall reinforced concrete roundhouse, a boiler house, an office building and sanding facilities at Grand Rapids, Mich., to cost approximately $100,000.

The Norfolk & Western has been authorized by the Interstate Commerce Commission to install automatic control on one passenger locomotive division between Shenandoah, Va., and Hagerstown, Md., in lieu of the installation originally required.

The Victoria Falls and Transvaal Power Company Limited, has applied to the electricity control board for an amendment of its license in order to build a new station on the Witbank coalfields. The estimated cost of the power station and transmission lines is about $5,000,000.

George Le Boutillier, vice-president of the Long Island, addressing the Long Island Press Association and the Long Island Association at the Clifton Hotel, Patchogue, L. I., on July 16, announced that he had prepared a program for additions and betterments on the Long Island calling for the expenditure of $84,000,000 in the next ten years.

A. S. Moody assistant Northwest manager of the General Electric Company, has been appointed local manager of the Los Angeles office of the same company, to succeed R. L. Cash, who has been transferred to Schenectady, Mr. Moody is well known in the electrical industry on the Pacific Coast, having been identified with the General Electric Company in that section for the past 16 years.

High speed tests of the locomotive ordered by the Paris-Orleans Railroad from the General Electric Company will probably be held at Erie, Pa., some time in August. This locomotive, now nearly completed, will be a 120-ton machine of special construction, operating at 1,500 volts. It will be equipped with gearless motors, two 3-axle driving trucks, a 2-axle guiding truck at each end and two box cabs. The length over all is 62 ft. Speeds in excess of 90 miles an hour are expected.

The W. N. Matthews Company manufacturers of mechanical painting equipment and railway electrical specialties, St. Louis, Mo., has been reorganized as the W. N. Matthews Corporation, with the same headquarters. W. N. Matthews continues as president of the new company and C. L. Matthews as vice-president and secretary. C. C. Fredericks, general manager of the W. N. Matthews Company has been elected vice-president and general manager of the new corporation and A. G. Williams has been appointed manager of railroad sales. Mr. Williams started as a mechanical apprentice in the Altoona, Pa., shops of the Pennsylvania Railroad and was promoted through various positions to that of engineer of motive power of the Southwestern region, with headquarters at St. Louis, Mo., which position he resigned on May 1 to take charge of the railroad sales of the mechanical painting equipment of the W. N. Matthews Corporation.

The Illuminating Engineering Society, 29 West 39th street, New York City on July 2, elected new officers for both the Council and section for the fiscal year 1923-1924. The names and titles are as follows: *National Officers*—Clarence L. Law, president; Samuel G. Hibben, general secretary; L. B. Marks, treasurer; D. McFarlan Moore, vice-president; James P. Hanlan, Howard Lyon, H. F. Wallace, directors. *New York Section*—L. J. Lewinson, chairman; J. E. Buckley, secretary; S. K. Barrett, H. W. Desaix, E. E. Dorting, J. R. Fenniman and E. H. Hobbie, managers. *New England Section*—Walter V. Batson, chairman; Julius Daniels, secretary; Cyrus Barnes, A. W. Devine, W. S. Fitch, R. W. Hosmer and J. A. Toohey, managers. *Philadelphia Section*—H. Calvert, chairman; J. J. Reilly, secretary; H. B. Andersen, G. A. Hoadley, M. C. Huse, Howard Lyon and E. L. Sholl, managers. *Chicago Section*—F. A. Rogers, chairman; E. J. Teberg, secretary; A. L. Arenberg, W. S. Hamm, N. B. Hickox, W. E. Quivey and E. D. Tillson, managers.

The ferries on the Delaware River from Camden, N. J., to Philadelphia, which on a holiday or a Sunday are always crowded with automobiles returning from the seashore, delivered into Philadelphia on a recent Sunday, between 4 p. m. and 10 p. m., about eighteen thousand cars. The Philadelphia Public Ledger, reporting the incident, says that at midnight 10,000 automobiles were waiting to be taken on to the boats. A detail of 25 policemen in addition to the traffic policemen were required to straighten

out the tangle. Motorists caused confusion by tooting their horns when it was announced that Federal and Market streets, the main traffic arteries leading to the ferry, were closed to pleasure cars and that farmers' trucks loaded with produce would be given preference. The chief of police said he considered the moving of foodstuffs more important than the transportation of pleasure seekers. In numerous instances drivers who waited in line several hours caused delay by falling asleep at their wheels. It required nearly three hours for cars at the end of the line to get across the river. The ferry boats were operated on a two-minute schedule and each boat carried twenty automobiles. On Saturday for a part of the time the Pennsylvania Railroad assigned two ferryboats to carry automobiles alone, but that only partly relieved the congestion.

The Mexican Government has announced the organization of a National Commission of Motive Power, for the organization, development, planning and supervision of the commercial exploitation of the natural power resources of the Republic. Studies will be made of the legislation in other countries relative to the developments of hydroelectric power, and the generation and sale of electrical energy. The commission's program includes advising the government which bodies of water should be withheld from power exploitation; division of the principal rivers of the country into sections according to their respective possibilities for power or irrigation development; revision of the Federal or local tax laws which may hinder the establishment and operation of hydroelectric plants; study of the advisability of abolishing or modifying the present Federal tax on water concessions; study of the desirability of preserving, restricting or extending the privileges generally granted to power companies; assistance to power companies in obtaining subventions from the government when it is considered that these are for public interest; and the study, in co-operation with local authorities, of the desirability of electrifying certain railroad and street car lines. It is planned also to exercise control and supervision over hydroelectric plants already functioning with a view to possibly revising the privileges which authorize the establishment of these plants. Similar plans will probably be developed where the energy is generated from sources other than hydraulic.

Proposed Electrification in Spain

Representatives of Morgan & Company of New York, Messrs. Rothschild of London and Messrs. Urquijo, the Spanish bankers of Madrid and Bilbao, have recently formed a company with a capital of 500 million pesetas (approximately $100,000,000 at par exchange), to carry out the long-discussed project for an electric line between Madrid and Valencia according to a dispatch from Barcelona to the Times (London) Trade Supplement. The line will be about 220 miles in length and double-tracked.

The project includes the development of hydro-electric power necessary for the new line, as well as the working of several mines, and other schemes of an agricultural character. It is stated that the work will be put in hand as soon as possible, embodying the proposals of the engineers, Messrs. Vallejo and Membrilla.

The capital of the new company will enjoy a state guarantee of five per cent interest. Besides being the first electric trunk line to be constructed in Spain, the project is one of the most important of its kind that has been launched in the country for many years. The new railway will open up a new country rich in minerals and in agricultural produce but hitherto devoid of communications.

Of the Trans-Pyrenean railways which are being constructed under the Franco-Spanish Agreement of 1904, the line from Ripoll to Puigcerdá is the only section at present in working order. The Minister of Public Works has now been authorized to ask for tenders for its electrification. The line is about 40 miles in length, with two long tunnels of a total of 3.7 miles. There are eight stations, some of which are not yet complete. The line rises to a height of 3,900 ft. in the tunnel under the Pyrenees; eventually it will connect with the French lines at Aix-le-Termes and will shorten the journey between Barcelona and Toulouse by 75 miles.

The Norfolk & Western Magazine

Volume 1, Number 1, of the Norfolk & Western Magazine, the June issue, has been distributed. The magazine has 84 pages, 8 in. by 11 in. It is well illustrated and printed on a good quality of coated paper. Many interesting articles about the railroad appear in the first number as well as special features dealing with house building, cookery, fashions, radio, sports, new books and general news. Holcombe Parkes, formerly associate editor of the *Railway Age,* is the editor of the new publication.

A 24-Hour Locomotive Run

Hauling a special train of 10 cars carrying Shriners on their return from Washington, locomotive No. 411 of the Missouri-Kansas-Texas, starting from St. Louis, Mo., on June 10 at 4:25 p. m., was run through to Austin, Tex., 975 miles, without being detached from the train and arrived at destination on schedule time at 5 p. m. This locomotive, an oil burner, consumed on the trip 7,335 gallons of fuel. The rate of speed figures out 39½ miles an hour and the fuel consumption at 7½ gallons per mile.

United States Civil Service Examination

The United States Civil Service Commission announces the following open competitive examination: radio engineer, $4,000 to $5,000 a year; associate radio engineer, $3,000 to $4,000 a year; and assistant radio engineer, $2,-000 to $3,000 a year.

Applications will be rated as received until October 30. The examinations are to fill vacancies in the positions named, or in positions requiring similar qualifications, in the Federal classified service throughout the United States.

The duties are to conduct or superintend the development, design, construction, installation, standardization, and the writings of specifications for practical and special apparatus and methods of radio communication, such apparatus to include sets for land use for more or less permanent stations, also for portable land stations, and for airplane and ship sets, and similar lines of work.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects: Education and preliminary experience, 30 per cent;

special experience and fitness, 40 per cent; publications, reports, or thesis, to be filed with application, 30 per cent.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customers in any city.

Trade Publications

The Crouse-Hinds Company, Syracuse, N. Y., are distributing two illustrated folders, one describing flexible fixture hangers and the second, vapor proof condulets and reflectors.

The Ohio Brass Company of Mansfield, Ohio, is distributing its O-B bulletin No. 2. The bulletin contains an interesting article entitled "Essential Aids to a Manufacturing Plant."

The Thompson Electric Company, Cleveland, Ohio, has recently issued a 4-page folder illustrating and describing the installation methods used with the Thompson lamp maintenance hangers. The illustrations show the fixtures arranged for all types of conduit fittings.

Yale & Towne Manufacturing Company, Stamford, Conn., has just issued a small envelope folder which contains a detailed description of plain and geared type of new Yale steel plate roller bearing trolleys as well as a description of the new Yale cast iron trolley.

Johns-Pratt Company, Hartford, Conn., are distributing their new catalogue No. 51 entitled "The Noark Service System." The catalogue is 8 in. by 10½ in. and contains 40 pages. The book is well illustrated with photographs and diagrams.

Sangamo Electric Company, Springfield, Ill., has recently issued its bulletin No. 61 describing and illustrating the Sangamo Type H single and polyphase watt hour meter. The bulletin contains 20 pages and is well illustrated with photographs and diagrams pertaining to the proper connections of these instruments to various circuits.

The Jefferson Glass Company, Follansbee, W. Va., has just issued its catalogue, No. 35, describing and illustrating a large line of semi-direct lighting bowls, reflectors and commercial units which it manufactures. The catalogue is 9 in. by 12 in. in size and contains 60 large plate reproductions of various types and sizes of glassware for use in illumination.

Manganese Steel Forge Company, Philadelphia, Pa., is distributing two envelope folders describing the properties and advantages of manganese steel rods and electrodes for electric and gas welding. These rods are marketed under the trade name of Rol-Man. They contain from 12 to 15 per cent of manganese, which metal makes them tough, strong and non-magnetic.

The Ivanhoe-Regents Works of the General Electric Company, Cleveland, Ohio, is distributing its catalogue 373A entitled "Lighting Equipment for Railroad Service for Outdoor Lighting." The booklet contains 16 pages and measures 7¾ in. by 10½ in. Standard pole reflectors, shallow dome reflectors, R. L. M. reflectors, flat concentric reflectors and prismatic refractor units are listed and illustrated.

The Conveyors Corporation of America, 326 West Madison street, Chicago, Illinois, have just issued a handsome booklet, "Representative Installations." The booklet contains illustrations of a number of notable buildings and power plants which are equipped with their American Steam Jet Ash Conveyor. A few installations are shown. Copies of the new booklet will be sent to any who are interested in the steam jet method of ash handling.

Service to the Central Station Industry is the title of a 36-page illustrated booklet recently issued by the Associated Sangamo Electric Companies. The booklet is known as Bulletin No. 63 and contains historical sketches of many of the men who were pioneers in the development of electrical science. A portion of the bulletin is devoted to a description and illustration of the methods used in the manufacture and testing of Sangamo meters in the various plants where these instruments are made.

Axle Light Equipment.—The U. S. Light and Heat Corporation, Niagara Falls, N. Y., is preparing a series of bulletins under the general title of "Axle Equipment Parts," which supplement and bring up to date Bulletin 208. There will be five of these bulletins, each consisting of a four-page folder, and the subjects covered are as follows: U S L Panel, Type C, Form 303 and C 304; U S L Lamp Regulator, Type B, Form 32; U S L Generator, Type O B H, Form 6-7-8-9; U S L Lamp Regulator, Type B, Form 33; U S L Generator, Type C B H, Form 17.

Each of the folders includes two large photographs, one of which shows the apparatus assembled and the other of which is a photograph of each different separate part. The parts are numbered on the photographs and a table is also included in which are listed the part numbers, the code letters, the number of each kind of part required and the name or description of the part.

The Supply Catalogue of the Westinghouse Electric and Manufacturing Co., is now being distributed. This issue for 1923-24 replaces and supersedes all catalogues issued heretofore on electrical supplies by the company. The new catalogue does not differ greatly from the former editions. The catalogue is indexed according to subjects and to sections, and also has a style number and a thumb index. In addition, a new feature—a classified index—has been added to the introductory section under the title "How this catalogue serves." Here is listed apparatus of particular interest to Central Stations, Electric Railways, Industrial Plants, Mines, Contractor-Dealers, and Architects. A complete list of all Westinghouse sales offices, agent jobbers' warehouses, service repair shops is also given together with several illustrations of new combination sales, service and warehouse buildings either recently built or now in course of construction.

There are 1,300 pages devoted to descriptive matter, technical data, dimension drawings, specifications and prices. The material includes all new apparatus developed in the last two years. The street lighting section probably shows the greatest revisions and over 175 pages are devoted to this feature.

All sections have been completely revised and some rearranged, which greatly facilitates the ordering of equipment.

Railway Electrical Engineer

Volume 14 SEPTEMBER, 1923 No. 9

Excessive Lamp Renewals

An interesting example of lamp renewal requirements is shown by the experience of a western railroad during and following the period of federal control. In 1918 wages were increased; the retroactive feature resulted in many of the shopmen, who had never made a practice of saving money, suddenly finding themselves with considerable sums on hand. At one large terminal a number of the men decided that rather than buy silk shirts, they would use some of this money for wiring their houses for electric light. Many more felt the necessity of "keeping up with the Joneses" and the movement became popular with the result that practically all who did not have electric lights had them installed. This wiring mania extended over a period of about a year and during this year the shop records showed that lamp renewals in the shops had trebled. This seemed excessive, even if the shop had been called upon to furnish all of the lamps for the houses. The electrical engineer was consulted and on looking over the situation he discovered that the shop voltage was 110 while the city voltage was 120. He instructed the shop engineer to increase the shop voltage to 120 and to order 120-volt lamps in the future. The result was that the shop lamp renewals decreased 50 per cent.

Another road wished to experiment with 6-volt headlights and to avoid the use of automobile lamps in the locomotive cab, a 32-volt circuit was used in the cab. Still another road decided recently that while 32-volt lamps for the headlight were satisfactory, 6-volt lamps should be used in the cab. To avoid excessive renewals special 6-volt lamps with Edison bases were used in the cab.

A number of roads use 220-volt circuits for the lighting of buildings. This makes the lamp used in the shops entirely unsuitable on 110-volt circuits, but does not entirely eliminate experimenting with the lamps for this purpose. Furthermore, a 220-volt lamp is not as rugged as the same type of lamp designed for 110-volts and neither the lamp nor the voltage is well suited for portable extensions.

Many roads use guards or lock-sockets and a theft-proof lamp has recently appeared on the market. More often no provision is made to cope with the situation and among the cases where an effort is made, the practices vary widely. As a result, lamp renewals, by and large, are excessive and there are many places where, if the railroad does not care to supply the neighboring territory with lamps, an appreciable saving could be made.

Control for Shop Motors

The use of electric motors in railway shops dates back many years. It is true, however, that their more extensive and intensive use is a matter of comparatively recent years. It is not so long ago that a single motor was considered sufficient to operate an entire shop, all machine tools being belt-connected to a line shaft; indeed in some places this practice is still in vogue. In the more up-to-date installations where some attention has been given to the efficient operation of both motors and tools, the one-motor layout has disappeared. Group drives and individual drives have been found more efficient and productive of increased output at lower costs.

As the practice changed from the one-motor shop to the many motor layout it was inevitable that the methods of controlling such motors should change likewise. The result is that we have on the market today quite a variety of controlling devices for both a. c. and d. c. motors. As is the case with most apparatus made to meet a demand, these devices vary considerably in design and quality. Some are made to meet a price, while others have been designed with service as their aim.

There can be no question but that safe, dependable and convenient controlling devices are a very great asset to the proper operation of motors of all types, and this fact is being recognized more and more every day. Two factors which are of primary importance in motor operation are the safety of the operator from electric shock and the increased production which is the direct result of proper control. In general, the starting and stopping of motors has become an operation which can safely be performed by the most inexperienced workman. The apparatus is so designed that he cannot possibly receive a shock.

Some types of control equipment provide motor acceleration which is automatically performed in such a manner that the machine will come up to the correct speed in the shortest possible time consistent with the load. Start and stop push-button switches conveniently located to the workman save countless steps and time which are inevitably reflected in increased production.

No railroad today is so well off that it can afford to continue motor operation by obsolete methods and

most of them have recognized the fact to a greater or lesser extent. There are many shops in which control devices could be used with very great saving. The cost of such equipment is usually not a factor. If the operation is one which should be performed by a certain type of control device and this device is not provided, the loss involved by the lack of it in a remarkably short time becomes very much more than the cost of equipment. Analyze your shop motors and see how much money you can save for your road by installing proper motor control.

Do You Belong to the "Better Qualified?"

"We are handling more trains than ever before in the history of the yards," said an electrical foreman in a big terminal recently. "The new men are better qualified and the fellows are more ambitious than they used to be." "Better qualified" — "more ambitious" — there lies the answer in getting work done. There are perhaps isolated cases where men "better qualified" are not "more ambitious" but it certainly cannot be accepted as the rule. From the nature of the things the men who are better qualified must of necessity have had the ambition to make themselves so. There is no royal road to any achievement worth while and it is a foregone conclusion that any man whose services become more valuable must have taken the time and made the effort to make them more valuable.

This is just as true in the maintenance of car lighting equipment as it is in any other field of endeavor. There is considerably more to this work than carting batteries between the cars and charging plant. Washing out tanks and straightening plates are only incidents of the day. A man might do such work indefinitely and still be as far from becoming a valuable electrical man as he was the first day he came on the job. The first step to advancement is taken when a man begins to seek information concerning those things which are not so readily apparent. To build for success in any line where electricity plays a part, the "how" and the "why" must be mastered. When the underlying principles are once grasped and finally made one's own, future development is almost certain to be rapid. The fact that more trains were handled than ever before does not necessarily imply that the men have worked harder so far as physical exertion goes, for it very often happens that the men who accomplish the most appear to do it the easiest. The secret lies in the "know how." There is no lost motion, no wasting time in making unnecessary tests —in short, the fellows who are better qualified are the ones who are certain to make the better showing.

New Books

Car Lighting by Electricity. By Chas. W. T. Stuart, Foreman of Car Lighting, Philadelphia Terminal, Pennsylvania Railroad. 352 pages, 6 in. by 9 in., 250 illustrations. Bound in cloth. Published by Simmons-Boardman Publishing Company, 30 Church Street, New York, N. Y.

This book has been written to meet the need of the practical man as well as the engineer and the student. The use of oil and gas for car lighting having been superseded to a very great extent by electric equipment, it is essential that those engaged with the construction, operation, inspection and maintenance of car lighting equipment have available a practical discussion of the subject couched in language intelligible to the average non-technical reader.

The writer has presented the various phases of car lighting in a manner so that the practical worker in the field, the engineer, or the student, may find a discussion of such phases of the subject as may have a direct interest for him, or that may, in a general way, assist in the betterment of the art of car lighting. He has been given assistance by many of the electrical engineers connected with railway and car lighting companies and thus has been enabled to secure data of great value.

The text gives a brief history of railway car lighting; a general description of the three electric systems used—straight-storage; head-end, and the axle-generator systems; and a detailed description of the construction, installation, and operation of the axle-generator system, with the regulating apparatus, transmission, storage batteries, lighting circuits and fixtures. The testing and inspection of car lighting equipment is also discussed and many of the special tools developed for use in repair work are described.

A detailed description of the several modifications of the axle-generator system now in use makes clear to the reader, the particular features which distinguish the system as built by various manufacturers.

The present stage of development of direct-drive equipment for the axle-generator system of car lighting is described briefly, and there is also appended the specifications covering the car lighting Standards and Recommended Practices of the American Railway Association.

The term "profusely illustrated" may very properly be applied to this work; the many photographs, drawings, and charts, directly "tied-in" with the text, give a very comprehensive presentation of the subject. The book should prove immensely valuable to men interested in railway car lighting.

The Electrical Handling of Materials, Volume Four, by H. H. Broughton, Member Institute Mech. Engrs., Member Institute Elec. Engrs., etc., 1923. 334 pages, 8½ in. by 10½ in. Bound in Cloth. Published by Ernest Benn, Ltd., 8 Bouverie St., E. C. 4, London.

The volume is the final one of four on the design, construction and application of cranes, conveyors, hoists and elevators. The present book concerns itself with machinery and methods. There are twelve chapters in the book which bear the following titles,—Elevators and Conveyors, Belt Conveyors, Automatic Feeders, Handling Materials Automatically with Skip Hoists, Lessons from America in Bulk Handling of Materials, Handling and Storing of Grain, Suction System of Discharging Grain, Handling and Storing of Coal, Ore, and Similar Bulk Materials, Handling and Storing of Coal, Ore, and Bulk Materials (continued), Belt Shipping Plants, Panama Coaling Stations and Handling of Foodstuffs and General Merchandise.

The above outline is significant of the wealth of material which the book contains. There are 279 illustrations showing in great detail the design and application of the various equipments described. A large number of tables are also included which give specific information concerning the numerous details of the many different kinds of belt conveyors, bucket hoists, elevators, etc.

Yard View of Transcona Shops, Canadian National Rys.

Electrical Applications at the Transcona Shops

Canadian National Railways Make Extensive Use of Electric Energy—Heat Treatment with Electric Furnace

By Alfred C. Turtle

THE Canadian National Railways have acquired a number of important repair shops in its growth, one of the most important of them being the Transcona Shops, situated seven miles east of Winnipeg in the Province of Manitoba.

These particular shops were built by the Canadian Government for the Grand Trunk Pacific Railway in 1912 and were operated by the Transcontinental Railway until 1920, when the merging of the Transcontinental Lines with the Canadian Northern Railway commenced the present combination of railways now known as the Canadian National Railways.

Fig. 1—Charging, Leveling and Final Testing Room for Car Lighting Batteries

Every form of electrical work is handled here;—viz: remodelling and repairing of old car lighting equipment, installation of new lighting equipment in place of gas illumination, and also the conversion of existent gas fittings to electric wherever practicable.

Battery repairs of course form a portion of the work handled with their attendant evils of over sulphation, loss of capacity and recurrent washings.

Photographs of the shops in which the preparatory work in connection with car lighting are shown, Fig. 1, being the charging, levelling and final testing room.

We, of course, have the usual shop made units which the majority of railway shops would not be complete without. Such as isolated welders of the motor generator type, small electrical devices for various uses, heaters, tempering, furnaces, etc., but the purpose here is to show a few of those items which are not in the usual run of things or where radical changes have been made to bring otherwise obsolete methods up to date, etc.

For instance, in regard to the shop made welding resistances, the plant supplying this welding system was formerly a two-wire system operating from a 500 ampere, 50-volt, 1800 r.p.m. motor generator set, feeding the erecting shop.

This arrangement has been changed to a single-wire system in which we have grounded one-wire to the structural steel and thence to each rail. The two generators are coupled in parallel and the balcony welders brought down to a screen enclosed section close to the machines. This arrangement has enabled us to increase the number of welders approximately 40 per cent on account of the increased diversity factor and combination of two units into one. A number of small nichrome variable resistor

units were made up, as shown in the lower part of Fig. 2. This unit with its single wire made a compact and easily moved outfit. Some of these units were fitted to trucks as shown. This also adds to the flexibility of the system,

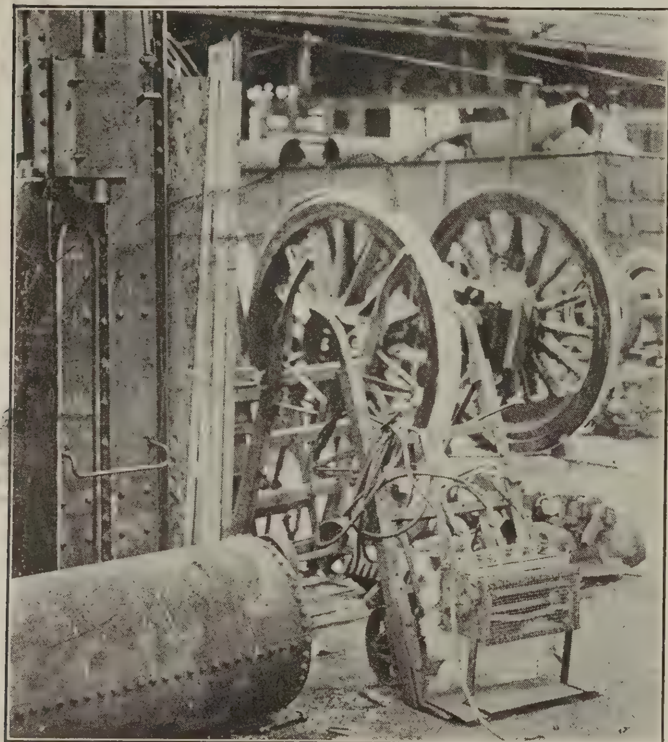


Fig. 2—Portable Nichrome Variable Resistor for Welding

for which idea credit duly belongs to one of the operators.

In the same illustration on the structural steel post is seen the type of safety switch self-grounding receptacle. These are used throughout the erecting shop supplying

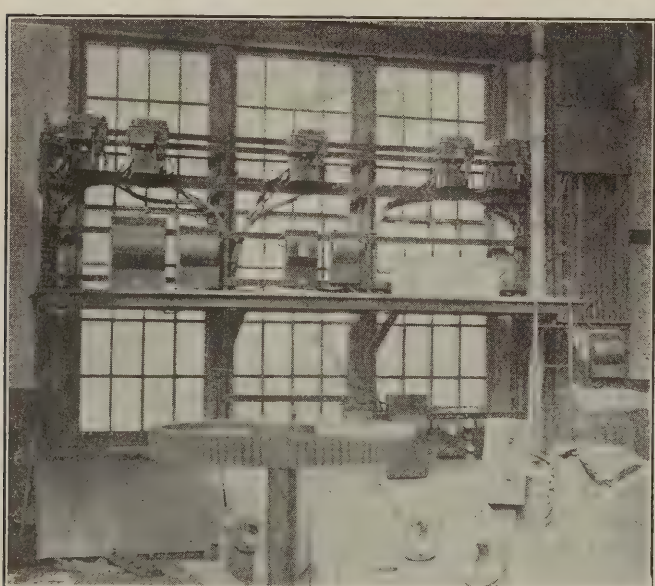


Fig. 3—Arrangement of Cable Protecting Circuit Breakers—Overload and No Voltage Relays

550-volt, 3-phase power for portable machine tools and electric rivet heaters, etc.

Fig. 3 shows a layout of the sub-circuit breaker controlling sub-feeders to the frog shop, boiler shop, machine shop and erecting shop, which is in process of construction and this control is arranged so that it will not take up valuable floor space and in order to do this was set up on a steel frame work with an operating platform 8½ feet above floor level.

A closer view of a similar arrangement taken from the operating platform Fig. 4, gives a clearer idea of this

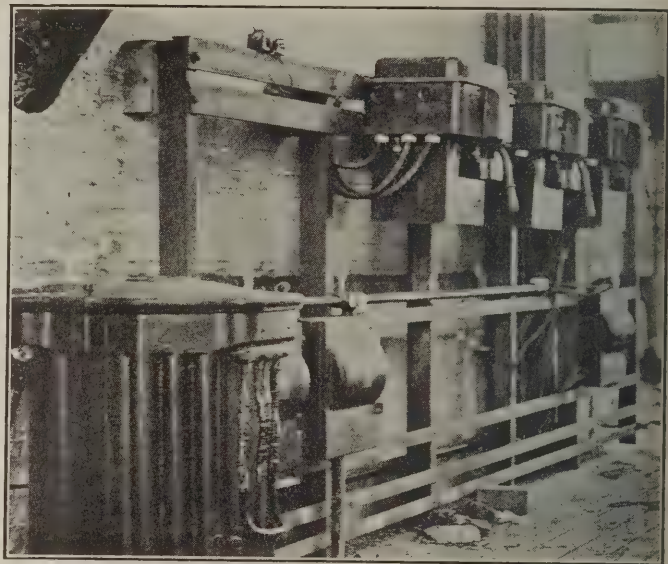


Fig. 4—A Closer View of Similar Equipment to That Shown in Fig. 3

structure. Room is provided for five oil circuit breakers for sub-feeder protection and the method of steel construction allows any size safety switch to be applied, as will be required in the future.

Distribution lines will eventually be run on racks, as shown in Fig. 5. This type of construction makes a very neat appearing job and does away with the necessity of using extreme dimensioned roof racks and unsightly angled lines.

Fig. 6 shows the winding machines in the electrical

Fig. 5—Exterior of Building Showing Distributing Line Run on Racks

shop set up on a table made up of angle and sheet iron welded into a solid structure. Loop, winder, former and taping machine are shown with magnet wire rack in the background.

Fig 7 shows a synchronous motor armature in process of winding and testing and part of the electric motor repair and maintenance shop.

In Fig. 8 is shown one of the soldering iron heaters in use in the same shop and the tinshop. These are very simply made up and are very effective for certain classes of work, particularly where a constantly clean iron is required.

A novel method of installing the main fire alarm receiving station is shown in Fig. 9.

This was made up out of the standard ornamental cast

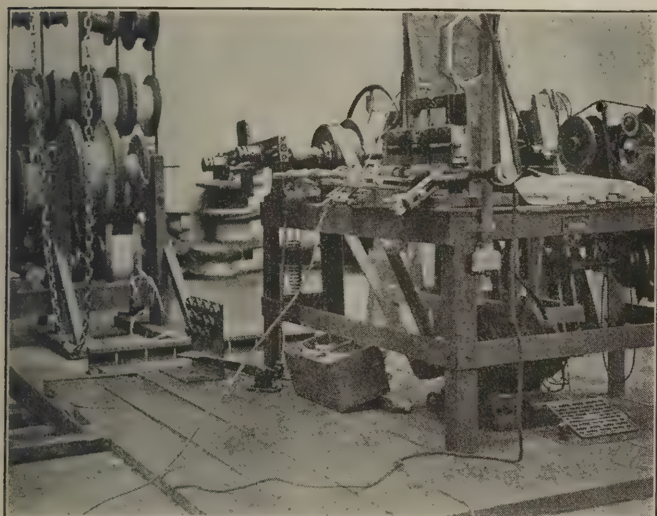


Fig. 6—One of the Winding Machines and the Wire Rack

iron lamp stand base used for platform illumination set over a 4-in. pipe. Scroll work was made up to suit out of 1/4 x 2-in. flat iron, and the gong, indicator, switchboard and automatic tape punch apparatus mounted thereon in suitable light oak finished cabinets. The batteries operating this apparatus were mounted on a mission style rack, also finished in light oak, making a complete

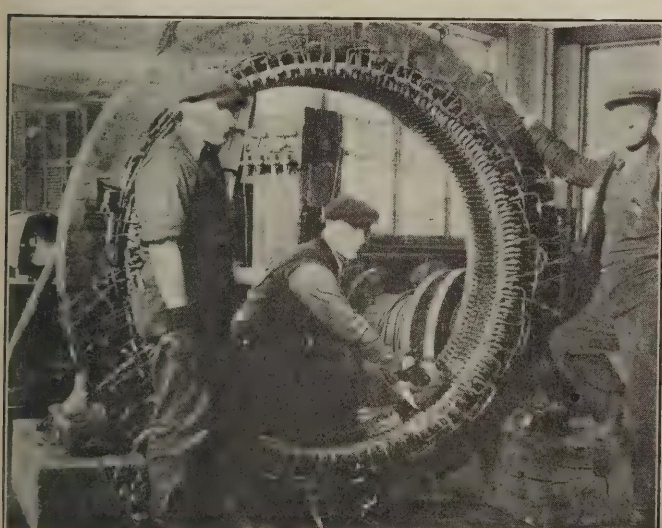


Fig. 7—Synchronous Motor Armature in the Process of Winding and Testing

and effective appearing unit. The whole is set up in the power house in line with the main switchboard.

Shop Lighting

Illumination is given its rightful place in its importance as far as working conditions and efficiency are concerned, as for instance, in Fig. 10, showing part of the erecting shop at night. This shop is equipped with Benjamin angle reflectors. These are the 500-watt lamp size and are spaced equally and opposite between tracks, thus giving ample light in cabs and on motion work of engines. We have an average illumination of 4.5 feet candle per square foot over this area.

Figs. (night photos) 11, 12, 13, 14, 15, respectively, are sections of the general machine shop, foundry, millwright, forge, boiler shop, floor and units, respectively. Several of the smaller shops have received similar applications of illumination and each one has received particular attention in the application of suitable light.

For instance, in the millwright shop where an electric crane operates on overhead tracks, it was necessary to use a large number of small deep bowl units in order to give five lumens per square foot without appreciable shadow.

In boiler, frog and machine shop, larger units and wider spacing was permissible on account of greater height and larger area.

In the foundry and forge shops a combination of angle and bowl reflectors was required to effectually remove

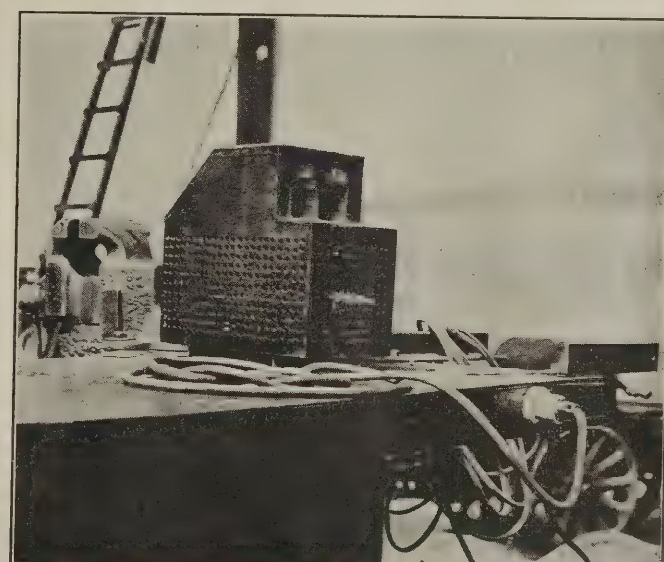


Fig. 8—One of the Soldering Iron Heaters

possible shadow producing effects. The results of this original scheme of lighting have proved to be better than expected, especially in the forge shop, where the different smoke stacks would have provided a problem to effect good lighting without shadow of more than ordinary difficulty considering the structural makeup and arrangements in this particular shop.

Another shop presenting difficulty in applying an effective lighting system is one which is 600 feet long by 195 feet wide (inside), and which handles the work of repairing all heavy bad order steel and wood box cars. There are eight tracks in this shop which handle the various freight car equipment and one track is taken up with straightening frames and the various machinery units used in fabricating the various parts for the steel cars.

The building is divided into three sections and two of these are served by means of electric cranes. These are fairly low roofed but not as low as the first section which we are commencing to illuminate, which is approximately 20 feet from floor line to lower horizontals of roof trusses.

Owing to three tracks being in use here and the box cars being placed end to end good lighting with little shadow is required and it is apparent that large units widely spaced would be ineffectual. Therefore a system of small units of both angle and deep bowl types are necessary to handle this and they must be of small size and closely spaced so that the ends as well as sides of box cars will be correctly lighted.

Electric Heat Treating Furnace

Figs. 16 and 17 show a car bottom electric normalizing furnace which was installed in the fall of 1922 particularly for the purpose of bringing the molecular structure of side

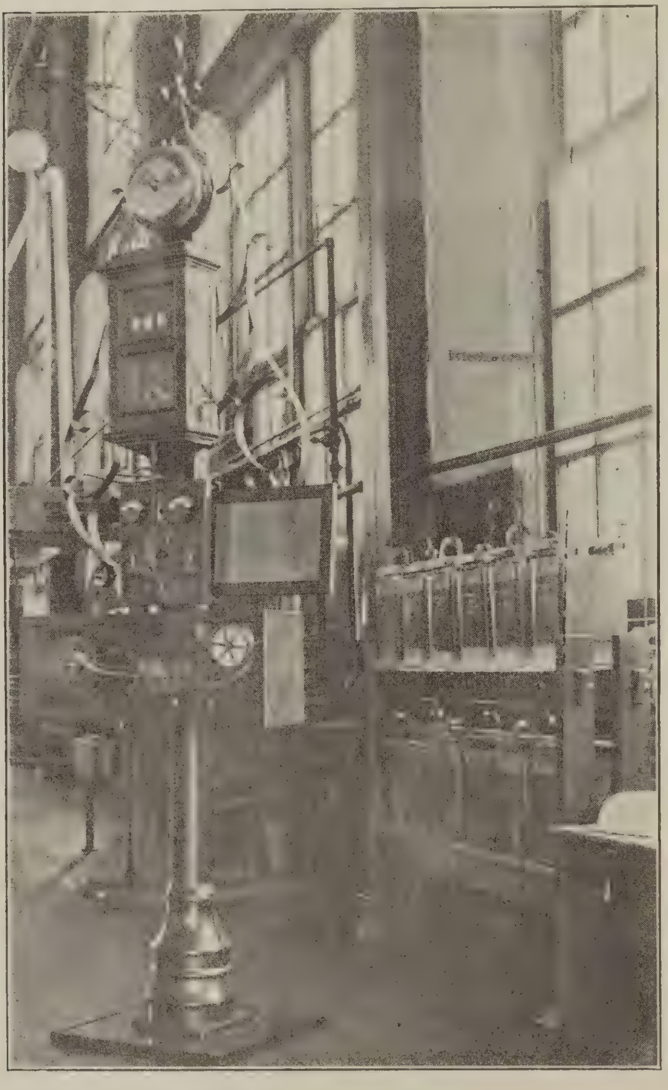


Fig. 9—Fire Alarm Receiving Station

rods to the conditions required for maximum service.

This apparatus was formerly intended for heat treating side rods, piston rods, crank pins and such portions of a locomotive that are subject to localized stresses and wear.

It is interesting to note how much more than the above that this apparatus has handled and to note the important lessons it is teaching.

Many railways have worked on the problems of requisite heat treatment and worthy attempts have been made to get results justifying such expenditures.

The heat treatment of the massive portions relative to locomotive work is in itself a difficulty and the methods used until recently have not conduced to make a success of this practice. Heat treatment is not always as simple as a certain text book would allow; which reminds the writer of a glowing pamphlet which once accompanied a certain medieval gasoline engine. Its description of starting this lacerating device was extremely simple (even a child could do it). The point might be conceded but believe him, it was "some" child that ever started that.

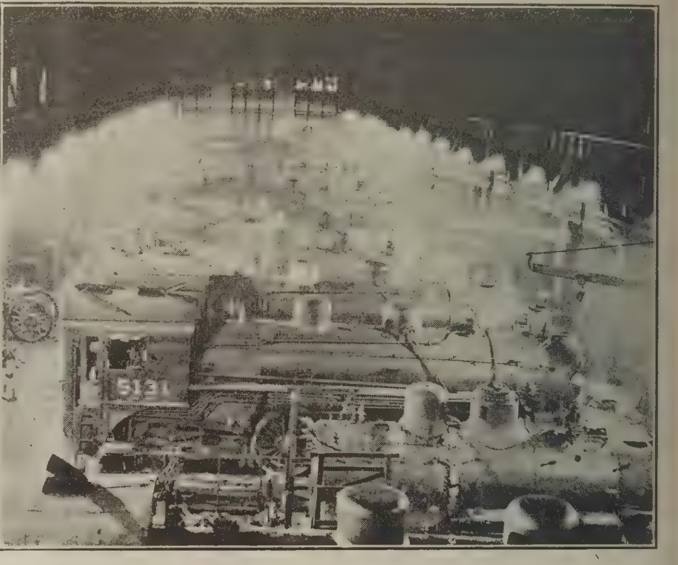


Fig. 10—Part of the Erecting Shop at Night

Much conscientious care and patience is necessary to evolve the correct result and something more than a blacksmith's fire and lime or oil bath is required to get profitable results and in order to prevent failures and reduce the heat treatments involved to the most simple operation it is important to use the best that science can give us.

For instance, what operator has not suffered from ex-

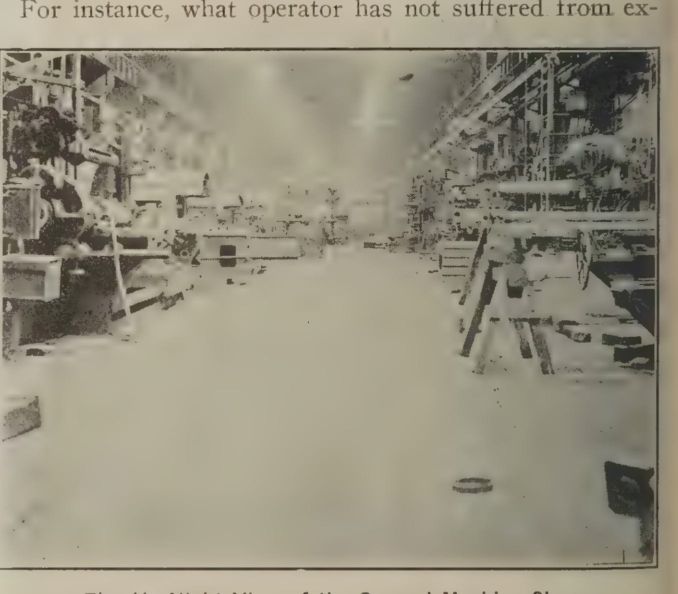


Fig. 11—Night View of the General Machine Shop

cessive localization of heat when heat treating steel in an indirect fired gas or oil furnace or has not come up against mysterious failures which, if he had a truly exact and truly even heated and air tight furnace, would never have occurred. In fact hundreds of such failures were never suspected as being due to excessive oxidization, carbonization, overheat and underheat.

Did not the pamphleteer always talk of the wonderfully even furnace that would not vary 10 degrees in any part, etc., and et al., and did not the steel expert trustingly put the pyrometer couple in the few couple holes left for him by the manufacturers and almost agree or if he did not quite like to give that brotherly acquiescence, did he not take it for granted that when the failure occurred that it must be something, in fact anything, other than the possible deviation of temperature in the furnace.

Fig. 12—Foundry at Night

Here is the latest application of heat that is controllable to limits never thought attainable in his particular application when using other fuels.

The furnace itself has inside dimensions of 15.5 feet in length, 4 ft. width and 20 in. high from floor plates to the spring line of the arch and 24¾ in. from the floor plates on truck to the inside centre of the arch. The element used is nickel chromium 80-20 wire, which is non-oxidizing practically up to 2,000 degrees Fahr., having an approximate length of seven feet bent in to six parallel lengths each. The insulation is approximately 16 inches thick and was designed so that its conduction and radiation characteristics would be such that a minimum loss of heat would occur. Such loss of course being finally fixed by the amount of time which is required to bring a batch of material down to 1,000 degrees F. or (below oxidizing heat in air) before drawing the truck.

Fig. 13—Millwright Shop at Night

The reader will understand that while this furnace when ordinarily charged has a rate of cooling when closed, approximating 30 degrees per hour, twice this insulation would probably mean that instead of a complete cycle of heat treatment taking 16 hours it would increase the cycle probably 60 per cent or 25.6 hours, which in turn would mean lower production.

The careful work of the designers of this unit is shown in the fact that with a 9,000 pound charge the furnace reaches the heat of 1,300 degrees F. only 100 minutes prior to the time the load is fully saturated.

The above results are no doubt due to the construction of this unit. For instance, while the furnace is a large unit it is as small as is permissible for our work and therefore the charge is crammed in and occupies every square inch of room available. With uncovered elements intense heat would be working on the charge closest to the elements and the centre of charge would be very slow in coming up to the heat of the outside charge. Warping and the stresses occasioned by such conditions on a charge consisting of long side rods would result unless the heating kw. input were reduced to a correspondingly low figure. This condition is overcome by using muffle plates which thoroughly cover the element and furnace walls so that a diffused heat is spread through the furnace and the furnace structure is therefore wholly heated up almost at the same rate as the charge but, of course, slightly faster. The actual radiation losses with furnace operating at 1,650 degrees F. were estimated at 48 kw. per hour or to give a thermal efficiency of 80 per cent.

Fig. 14—Night View in Forge Shop

The most important feature, however, differentiating from most furnaces of this type, is that while top and sides are thoroughly covered with heating elements the truck bed is similarly equipped and instead of a muffle plate of porcelain, as is used on the sides and top, a muffle of ribbed cast non-oxidizable metal is laid.

When metal to be treated is set in the furnace it is our custom to raise it off these plates on two-inch square bars and to allow reasonable spacing vertically and hori-

zontally between units so that heat circulation other than radiation will meet with minimum resistance. This of course helps to produce the ideal conditions quoted, but is limited by the amount of material which we put in which now regularly amounts to 8,800 pounds, approximately per cycle.

The actual power taken at full heat is 220 kw. at 180 volts, 3-phase, and this by means of transformer switches is cut down to 140 and 90 volts respectively. The whole is controlled by a system of contractor switches operated automatically from a Leeds Northrop potentiometer which can be set to control the furnace from a range of 500 degrees to 2,000 degrees F.

Two couples 36 in. long are suspended on counter weights and these are let down into the middle of the work one at the centre of each half section of the furnace. A check on all positions of the oven is regularly arranged with a master pyrometer and a remarkable evenness has been shown.

Most railway officers realize the crystallizing effects produced in steel rods and parts which are subject to

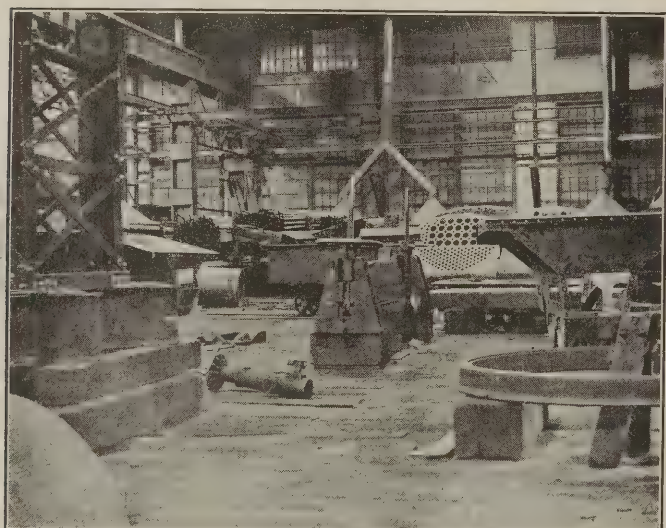


Fig. 15—Part of the Boiler Shop at Night

alternate tensive and comprehensive stresses and are of course also fully aware that some method of heat treatment is necessary to remove the effects of this service. This of course happens on all axles, piston rods, coupler pockets, steel and iron parts of trucks, engine side rod crank pins, etc.

Another branch where much damage is done to fabricated work is in the forge shop. This sounds rather condemnatory but the statement falls far short in expressing the actual condition that rules in every railroad forge shop on this continent.

Most railway men are wise to the effects on steel of phosphorus and sulphur and it is safe to say that these two substances have been blamed for innumerable failures which if traced down would have been found to be due to poor structure in the iron or steel caused by excessive local and counter expansions or contractions or over-heating above the decalescent point, which in turn are due to excessive heat being applied in the oil furnace or forge fire or else too quick air cooling.

This is not any fault of the forge shop and in fact, in order to get reasonable cost and production with the appliances at hand it is quite to be expected that there will be applied an oil fire blaze of from 3,000 to 4,000 degrees F. to the various sized steel bar flats and rounds for fabricating on bulldozers or under steam hammers.

If the forge shop foreman did not do this there would undoubtedly be someone in his place who would. Why?

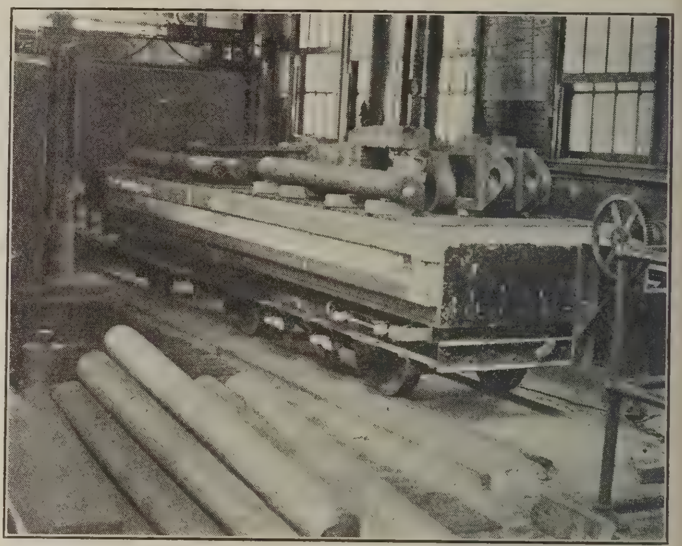


Fig. 16—Car Bottom Electric Normalizing Furnace

Because of the cost of production in general and the difficulty of handling the work otherwise in particular.

Take the case of a 10-inch diameter crank pin forging, what happens here? A good low carbon steel billet is taken and subjected to the oil flame until its general structure is as coarse as it can be made. Then when the outside is about melting point and centre hardly red it is subjected to the hammer and pounded into shape, the result generally

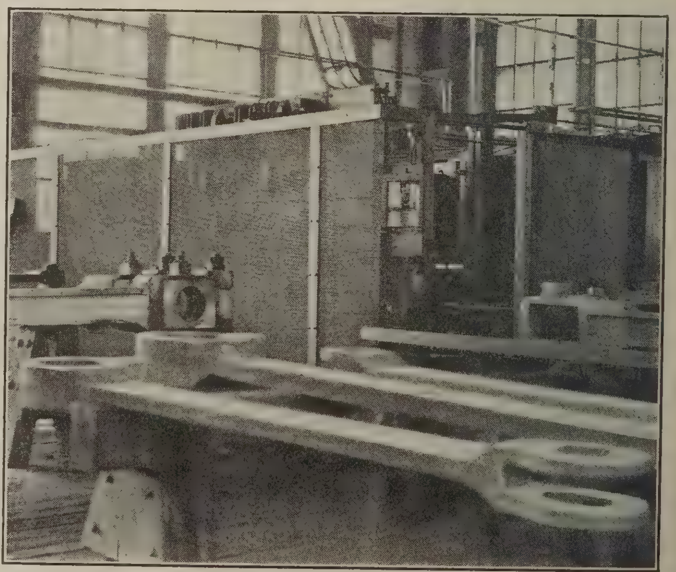


Fig. 17—Another View of the Electric Furnace

is, a weak enlarged crystallized structure instead of a tough medium hard and almost unbreakable unit which would resist eccentrically inclined stresses and wear.

Many similar transportation companies have realized this urgent and extreme necessity for heat treatment and some have no doubt gone farther in experimenting than

others, particularly in spending large amounts of money for furnaces of different types.

The remarkable results obtained in the electric furnace, particularly in reference to the type being used here in heat treating steel, etc., in to the various molecular structures are very greatly due to its inherent characteristics and as the metal to be treated is the governing feature, that is, its ability to absorb heat or thermal conductivity, etc., it must necessarily follow that the heat input into the furnace be at only a slightly faster rate than the absorption by the charge, if warping is to be avoided and if the ideal conditions, viz., molecular change at the lowest possible temperature is to be the result.

Then again, economy being the outlying reason for the amount of insulations used, is not finally the only reason. A perfect anneal can take place in such a furnace because of its absolute prevention of cold spots.

Where work is brought down to non-oxidizing point before being drawn to be air cooled, scale is conspicuous by its absence.

As radiation can be considered to be the most important method of getting the heat into the charge, it must be conceded that electricity offers remarkable facilities in the fact that absolutely perfect heat control can be applied to every square inch of the radiating surface available, whether it be roof, walls, floor or doors, and that, without the necessity of admitting air in any form, and also that that heat can be applied in intensive, radiant or diffusive forms, the latter method of course being most suited to problems where quantity of heat is required yet so carefully diffused throughout the charge that its admittance is only slightly ahead of the natural rate of conductions of that charge.

Investigation conducted into all classes of material from side rods down to box car coupler pockets and arch bars either with micro-photography, tensile or the common shop tests, have shown remarkable conditions as existing in any ordinary forge shop practice.

For instance, a sample arch bar was picked out of a group and a section was nicked and broken off with a sledge. A second section similarly treated was heat treated and then put in a rail straightening machine with suitable dies and bent 55 deg. out of straight in opposite directions four distinct times before it cracked at the nicked position.

Another piece of the same bar unnicked was bent similarly twenty times before cracking.

A sledge hammer test on the first heat treated section nicked produced no effect whatever.

This is a sample of rough shop testing but it shows that an increase in life of such steelwork could be made anywhere from 100 to 600 per cent.

The energy cost of so treating low carbon steel varies slightly from 90c to $1.10 per 1,000 lb. when purchasing energy at figure of 6/10 of a cent per kw. hour.

Labor, overhead, maintenance and fixed charges vary, depending upon local conditions, type of furnace, etc.

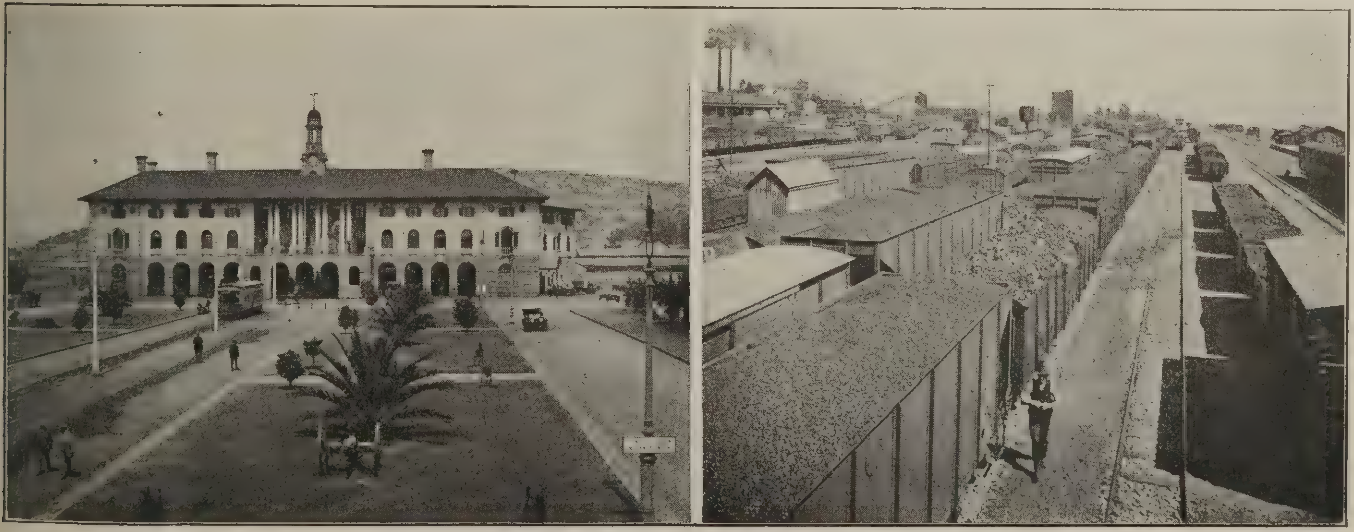
Motor Renders Long Service

STILL in use daily after 27 consecutive years of service in Sacramento, Cal., is the remarkable achievement of a Westinghouse motor in the shops of the Atchison, Topeka & Santa Fe Railroad.

The motor, which is a Tesla Type B alternating current induction motor, 15 horsepower, 1,200 revolutions per minute, three phase, 60 cycles, 500 volts, was installed in 1896, only two years after this type of motor was developed. It has a rotating primary and a stationary secondary provided with a series of U-shaped resistance grids bolted to the rear ends of the secondary bars for starting duty.

When the motor is up to speed, the secondary is short-circuited by moving the large lever at the top of the motor frame, which is connected to the large copper ring visible inside at the top of the frame. This ring mounts a number of fingers which will make contact with the square bosses at the upper ends of the cross connections.

During the two years in which reports have been made to the Highway Safety committee of the Public Safety division of the Chicago Safety Council, 785 instances of carelessness exhibited by motorists in crossing tracks of steam and electric railroads have been reported by gatemen and flagmen in Chicago and vicinity. Of this number 195, or 24.8 per cent, are cases where damage has occurred to crossing protection equipment.



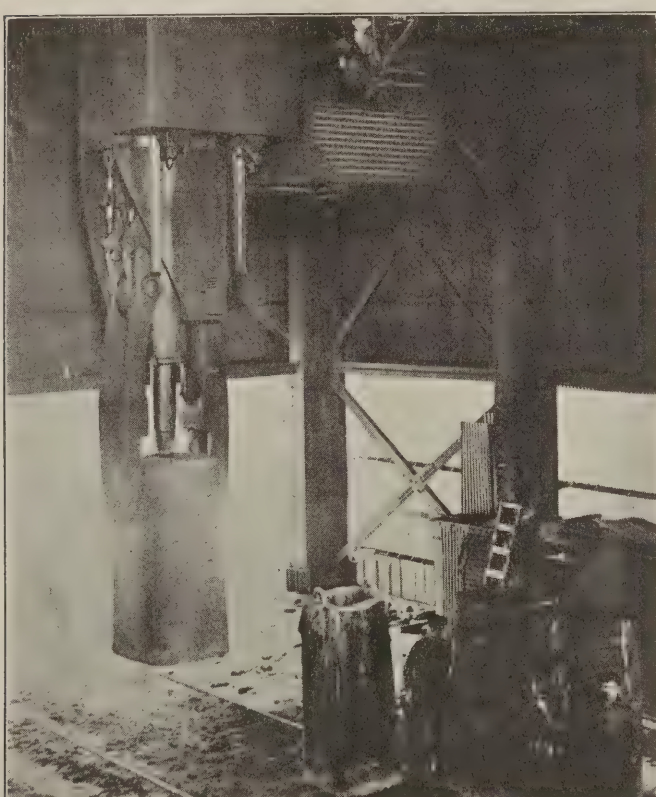
Station at Pretoria and Coal in Witbank Yard, South Africa

Arc Welding An Ingot Stripper Ram

By A. M. Candy
General Engineering Dept., Westinghouse Elec. & Mfg. Co.

The arc welding process is justifiably becoming recognized as a valuable repair method for a large variety of heavy equipment. Quite frequently new applications are made which are of sufficient importance to be of interest to all maintenance departments. The writer considers the welding of a stripper ram to be in this category.

The ram under consideration is ten inches in diameter and was broken off about three feet from the lower end. With the ram lowered to the extreme limit the broken end was still between the tongs and only about twenty inches below the housing of the ram. At the upper limit of travel the broken end would be well up in the housing.



A 150-Ton Ingot Stripper Ram Repaired By the Arc Welding Process

This, therefore, eliminated the possibility of leaving any reinforcement at the point of the break.

These rams have been repaired in the past by other processes but in this case the writer was called in consultation to determine if it was not possible to use the arc process to make a saving in time and expense of performing the work and also produce a satisfactory job. After analyzing the problem we decided to undertake the job along the following lines:

A new tip for the ram was prepared from new steel stock leaving the upper end of the piece cut off flat on the end at right angles with the axis of the piece. The stub end of the ram was then beveled off from two sides to form a blunt chisel end, the point for starting the cut for each face being located above the end of the ram, a distance equal to the radius of the ram, namely five inches. Each face was cut parallel with a plane through both of the tongs so as to be easily available to the welder and not to have the tongs in the way.

The new tip was then secured in position and proper alignment with the ram obtained by means of two bolts on opposite sides of the pieces, these bolts passing through two clamps, one secured near the upper end of the tip and the other secured to the ram just above the beveled faces. These bolts were located adjacent to the tongs so as not to interfere with the welders.

This job was carried out during cold weather, and, therefore, to make it possible for the welders to work continuously, a platform about eight feet square was constructed at the correct height under the ram so that the welders could easily reach the surfaces to be welded. A housing and roof was constructed around and over this platform to protect the work and welders from the wind and snow. A stove was also provided in the improvised house to keep the temperature sufficiently high so that the men could work with comfort, which is absolutely essential for good welding work.

This job was started at five p. m. and completed at seven-thirty p. m. the following day by two welders working straight through. Approximately one and one-half hours were lost due to power trouble and about two and one-half hours for meals. The total welding time was therefore about nine hours or eighteen man-hours. Approximately one hundred pounds of three-sixteenths inch diameter welding wire was used.

The alignment of the new tip with the main portion of the ram was almost perfect and after grinding off the excess weld metal the ram could be drawn up into the stripper boom without any binding. This alignment was easily maintained by having two welders work at the opposite sides at the same time depositing an equal amount of metal on each side.

The cost of carrying out this work was much less than by the former methods and the stripper was ready for service about twelve hours sooner, which is an important item.

By perusal of the table of costs it appears that the cost of repairing a ram even by the arc process shows only a slight saving over the cost of a new ram. However, the delay in obtaining a new ram would amount to several times this value due to keeping the stripper out of service.

New ram 30 ft. long, 10 in. diameter	$200.00
Remove old ram and install new ram	100.00
Total	$300.00
Old method of welding	$500.00
Cost of preparation	48.50
Cost of finishing	5.00
Total	$553.50
Arc Welding	
Welding labor and material	$200.00
Cost of preparation	33.50
Cost of Electric power	6.00
Cost of finishing	2.00
Total	$241.50

A water power plant has recently been completed in Switzerland which operates on a head of 4,870 ft. The static head when the wheels are not running is 5,400 ft. The velocity of the water at the nozzle of the waterwheel is 550 ft. per sec. There are four waterwheel-driven generators in the plant each developing 2,800 kva.

Train Control Device Tested by the Big Four

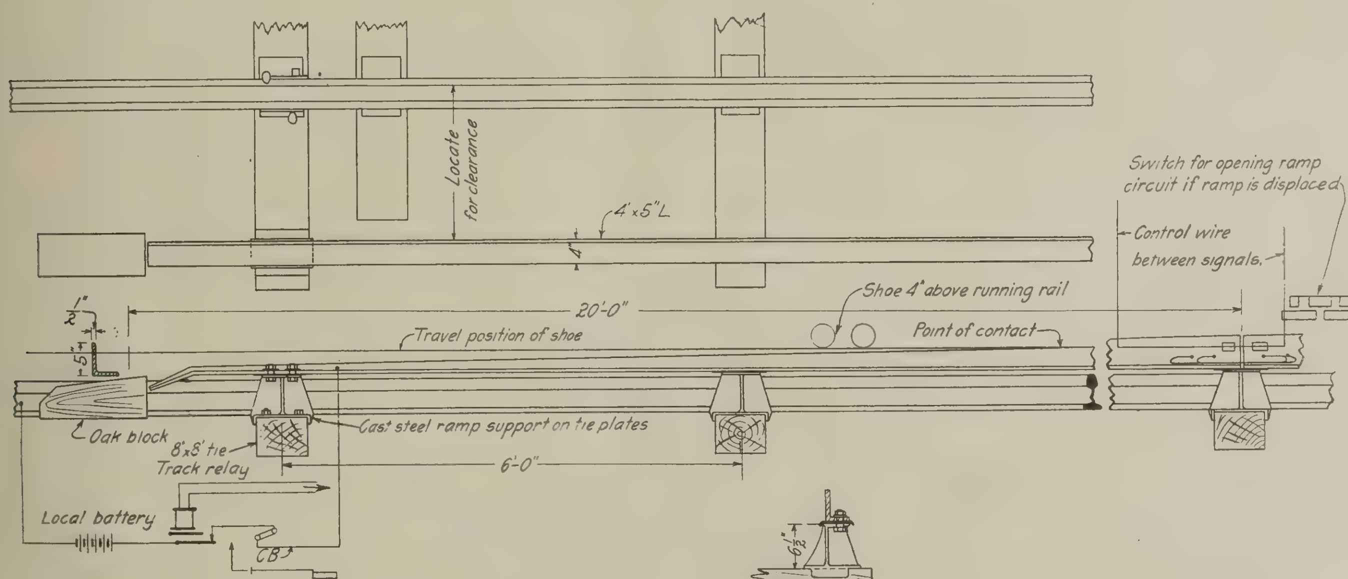
Indiana Equipment Corporation Demonstrates Its Apparatus in Connection with Freight Train Service

TESTS of an automatic train device which has been developed by the Indiana Equipment Corporation, Indianapolis, Ind., were recently made on the St. Louis division of the Cleveland, Cincinnati, Chicago & St. Louis at Avon, Ind., approximately 10 miles west of Indianapolis. These tests were made on a descending grade of 12½ ft. per mile. A Mikado type locomotive was equipped with the apparatus and the roadside elements were located at two signal locations on the east-bound main track east of Avon.

The principal parts of the locomotive equipment are the shoe housing and shoe, the automatic brake valve, the control relay, and the speed controller. The shoe consists of a malleable casting supporting two large steel rollers, so arranged that three contact points ride on the ramp rail. These contacts were designed with a view to insuring electrical contact with the ramp. Before the front roller makes contact the rear roller is slightly lower in the housing than the front roller, thus permitting it to make contact with the ramp before the front roller makes contact. The stem, supporting the roller housing, is equipped with heavy buffer springs, both front and back, to equalize the shock around the stem. The upper part of the stem is surrounded by a heavy hub bearing with a bolt passing through the bearing and the slotted stem. The stem is of steel tubing and is supplied with a spring buffer to act as a cushion for the housing. The upper part of the stem supplies movement to two circuit breakers. Two safety rods are used in supporting the shoe, and they are so arranged that if they should break, they will allow the shoe to drop about ¾ in. which will cause a service application of the brakes on the train. The shoe and the stem have been designed so that their weight insures the return of the shoe to its normal position after leaving the ramp. The shoe is contained in and supported by a built-up housing of a boiler plate steel angle and cast steel end guides, and is located on the rear truck of the engine tender.

Operation of Brake System

The automatic brake valve is of the slide valve type, following standard air brake construction. It accomplishes the required gradual brake pipe reduction according to the speed of the train under the dual control of the speed governor and the electro-pneumatic valve, and is provided with a differential valve to insure a brake application regardless of low brake pipe pressure. In action, this valve makes a gradual reduction of the brake pipe air pressure in order to prevent quick action of the brakes on the front of the train, and follows this with a gradual stoppage of the brake pipe exhaust, in freight service; in passenger service, it is adjustable for high speed quick action braking. The valve is constructed to co-ordinate with full efficiency of the E. T. brake equipment, and an automatic service application of the brakes approximates proper hand operation by the engineman of the engineman's brake valve. The valve makes a required brake pipe reduction and laps the valve to hold the brake on the engine and on the train. The automatic valve does not prevent the engineman from operating his regular brake equipment, or interfere with hand braking. However, if the engineman should make a light brake pipe reduction, the automatic brake valve will complete the operation, subject to the action of the speed controller. The engineman can hold the brakes on the engine and recharge his train without interference from the automatic valve. If the engineman operates the release switch, which is provided for that purpose, an automatic release of the brakes and the recharging of the train braking system will take place when the train speed



Two Views of the Construction of the Ramp, With the Circuit for the Ramp Feed

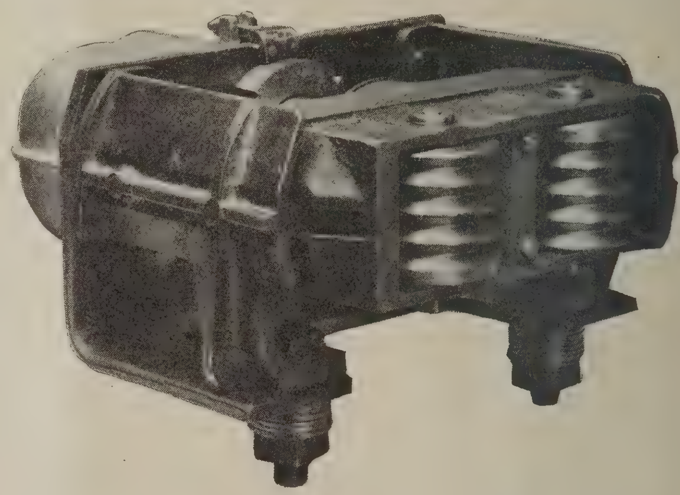
has been reduced to the predetermined safe speed limit. A train traveling at any speed, on entering a caution or stop block, will receive a full service application of the brakes unless the engineman operates the control switch in the cab. The operation of this switch will set up the speed control to govern the brake application, bringing the engine and train down to the predetermined permissive proceed speed, and it will prevent a brake application if the train is already traveling within the low speed limit. Should the engineman fail to operate this switch, the train will come to a full stop. When two or more engines are coupled together the brake control is cut out of service on all engines except the first one by means of closing the brake pipe double-heading valve in the brake system.

The Speed Control Mechanism

The speed control mechanism is of the centrifugal type, bolted on the end of the journal outside of a pony truck wheel, and operates as required to cause a service application of the brakes if a predetermined safe speed should be exceeded in traveling through a caution block or in restricted speed territory, around curves, or through crossovers or the approach thereto. The speed control has a manual control feature in connection with it, requiring the engineman to operate a switch manually to permit the train to pass a caution or a stop without a brake application, provided he is traveling with the predetermined safe speed limit allowable for passing caution and stop signals. A graduated service application of the brakes through the medium of the speed control is arranged in such a manner that a quick service application takes place for high speed and a more moderate application is provided for at lower speeds. For freight service, a limited high speed adjustment of 40 to 45 miles per hr. can be made on the speed controller if desired, which will govern and prevent excessive speed.

The speed controller is of heavy malleable iron construction. The controlling arms are located on the back plate, allowing no overhang and are arranged at right angles to the axle. The speed control circuit is so arranged in the system that if the speed controller should be destroyed, a service application of the brakes will result. Under such a condition the engineman can break a seal in a special condulet provided and place fuse plugs, thus cutting out the speed control apparatus in the system, and the train can then proceed under the protection of the simple automatic train stop.

Signals consisting of a yellow and a green light are located in the cab. A yellow light indicates an automatic application of brakes, while a green light indicates clear or high speed. A combination of the yellow and the green lights burning at the same time indicates a permissive proceed movement.

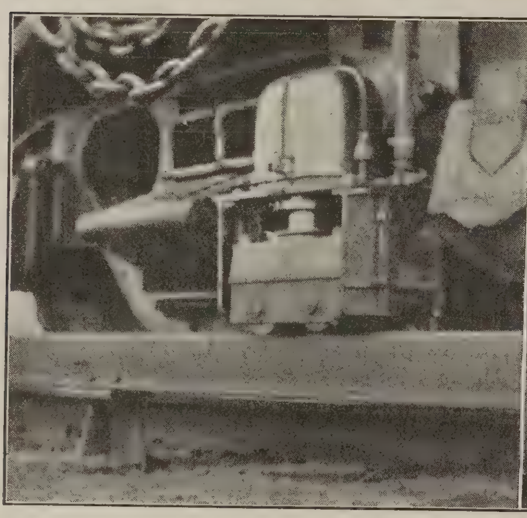


Shoe Showing Construction and Location of Contact Rollers

The Ramp

An 80-ft. ramp, located at the proper distance from the gage of the rail to insure clearance, and placed parallel to the rail is fastened on ties. The ramp is connected electrically through the track relay and the signal control circuit so that the removal of the ramp, or breakage in the ramp circuit, will cause the roadside signal to indicate stop and also will give a "stop" indication on the ramp one block in advance. The location of the ramp will be governed by traffic and train braking conditions.

The ramp is made of 4-in. by 5-in. L's, and is in four parts. There are two 20-ft. leads and two 20-ft. intermediate sections. The top of the ramp is planed, and the two end pieces are on a taper of 3/16 in. in 12 in. The ramp is held in place by cast steel ramp supports located at intervals of 6 ft. which are bolted to 8-in. by 8-in. sawed ties of the proper length to provide clearance for the ramp.



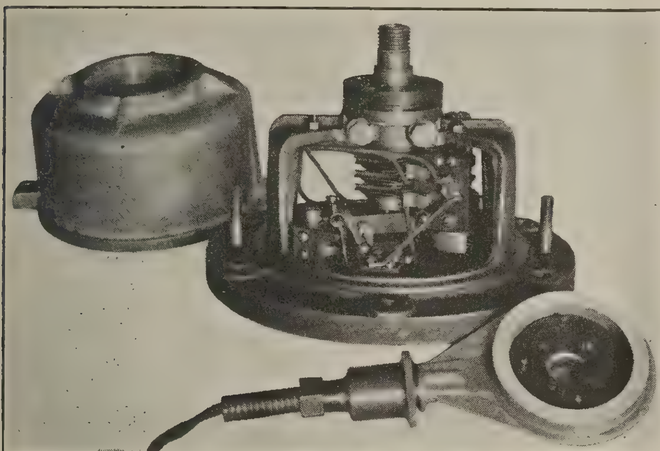
Shoe Engaging Ramp

Engine Approaching Ramp

Location of Speed Controller

Standard interlocking tie plates are used to tie the ramp in solidly to the track and to hold it in proper gage relation to the rail. The ramp is insulated from its support by 3/16-in. fiber insulation. Each end of the ramp is turned down and protected by a tapered oak block to prevent dragging equipment from causing damage.

The engine circuits operate on the closed circuit principle, and contain a specially constructed heavy electrically operated circuit controller for both clear and unclear circuits. The opening of any closed circuit will result in a service application of the brakes. The electrical controller and a 10-volt storage battery is suspended in a box under the engine tank.



The Construction of the Speed Controller

Tests Made

The train used in the tests was a local freight from Terre Haute, Ind., to Indianapolis, consisting of 22 loaded cars, 1,340 tons, and a Mikado type locomotive (Wt. 246,000 lb. on drivers. · Cylinders, 27 by 30) equipped with I. E. C. Train Control System and Westinghouse E. T. brake equipment. The air was cut out on two cars, leaving 20 cars with effective brakes. The train was stopped at Avon station, and the I. E. C. system was cut into service. The tests were made under the supervision of C. F. Stoltz, signal engineer, and C. B. Miles, air brake supervisor of the Big Four.

The first test was made with the train running at a rate of 35 mi. an hr. at the time the shoe passed over the ramp. The ramp was energized to set up a clear indication and the engine proceeded at speed.

The second test was made at the next ramp location, the ramp being de-energized for the approach to a signal in the "stop" position. The speed on passing over the ramp was 35 mi. an hr. and an automatic brake application was received. The brakes were released by the engineman pushing his control switch after which the train was brought to a stop by the engineman operating the brakes manually.

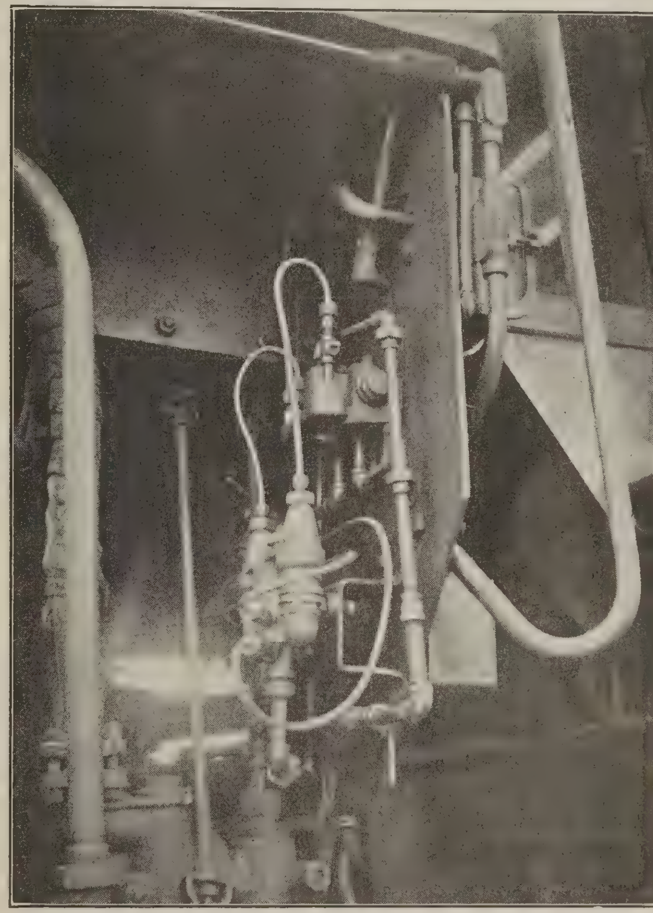
The third test consisted in backing the train up over a de-energized ramp at about 10 mi. an hr. An automatic brake application was received which stopped the train in about 300 ft. The automatic train control apparatus was effective with the throttle open and a smooth stop resulted.

Test No. 4 was made by backing the train over the next ramp which was also de-energized, the engineman operating his release switch, thus allowing the train to continue backing up under the low speed limit.

Test No. 5 was made with the train proceeding forward at a rate of 35 mi. an hr. at the time of passing over the ramp. As the ramp was de-energized, the automatic train control apparatus functioned giving a brake pipe reduction of 15 lb. in 11 sec. The train was brought to a stop in 2,900 ft. in 1 min. and 33 sec. The throttle was open until the train stopped. A smooth stop was made and there was no jar to the equipment.

The above five tests were made with the brakes on the train effective only; as the engine brakes were held off.

Test No. 6 was made by the train passing over a de-energized ramp at a rate of 35 mi. an hr. The automatic control apparatus caused a 15-lb. reduction, bringing the train to a stop in 1 min. and 10 sec. in a distance of 1,980 ft. The train was brought to a stop in a shorter distance in this test because the engine brakes were also applied by the apparatus.



Top Valve, Control Valve; Bottom Valve, Graduating Brake Valve for Split Application of Air

Test No. 7 consisted of the train passing a de-energized ramp at 25 mi. an hr. The train was stopped in a distance of 1,700 ft. in 1 min. and 2 sec. The engine brakes were also applied by the train control apparatus in this test.

Test No. 8 consisted of a series of tests on the operation of the speed control as the train proceeded towards Indianapolis. In these tests the train was accelerated until the critical speed was exceeded when the speed control apparatus became effective, applying the brakes and reducing the speed of the train to the proper rate. When the train had reached a speed a little below the critical speed,

it was again accelerated to a point where the speed control apparatus applied the brakes.

A number of these tests were made, the speed control in each instance functioning properly. All of the stops were smooth and easy, with no jar or damage to equipment.

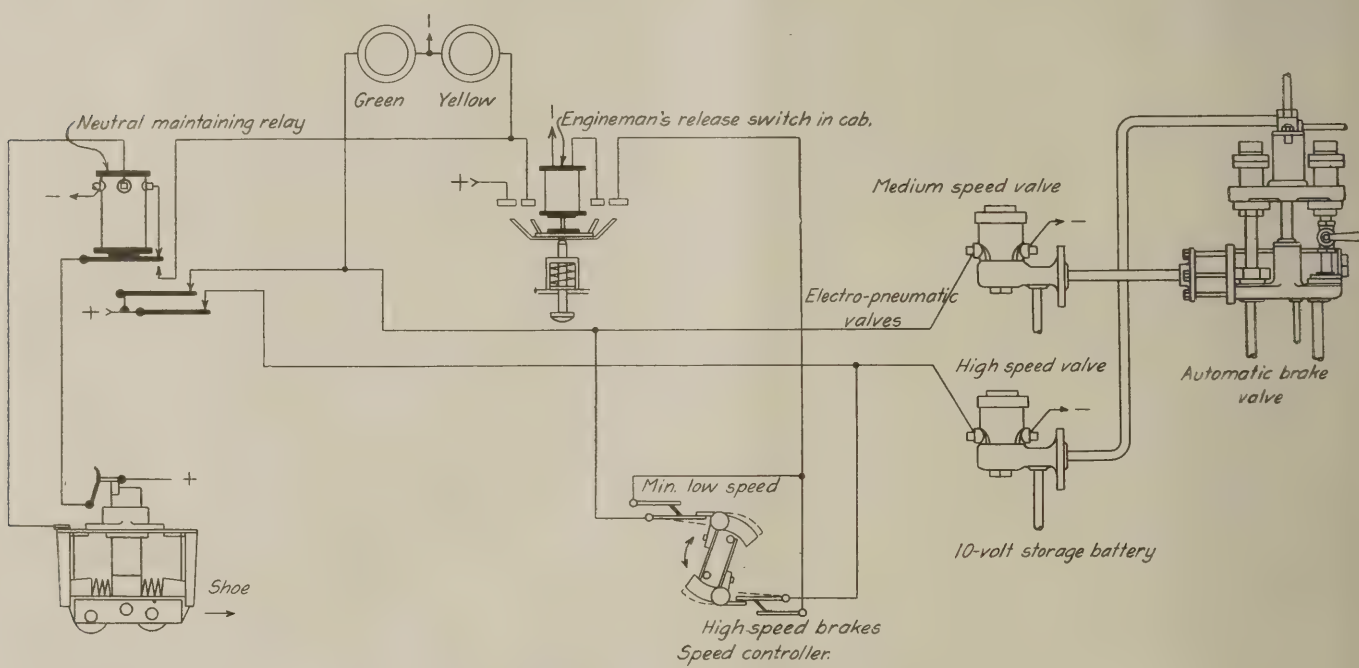
Later, a second test of the I. E. C. equipment was made on a 100-car freight train under the direction of Mr. Miles and C. C. French, assistant signal engineer. This train was not made up specially for the tests, but contained the regular run of cars. At Avon, the I. E. C. system was cut into service. Tests were made as the train proceeded to Indianapolis under ordinary running conditions. The train consisted of engines 6177 (equipped with the train control apparatus) and 6186, hauling 100 cars and the caboose, of which 77 were loads, and 23 empties, weighing 4,284 actual tons. The brakes were cut out on three cars on the train. The engines are equipped with an 8½-in. cross compound compressor and ET equipment with a U pipe connecting the application cylinder to the distributing valve release pipe, which prevented the application of the locomotive brakes with the brake valve in running position.

The first test was a standing test to ascertain the amount of brake pipe leakage, and the time necessary to apply the brakes on the rear cars under full manual operation of the automatic brake valve, and by the use of the train control. The time required to apply the brakes manually on the rear of the train with a 15-lb. reduction was 1 min. and 30 sec. (in the release tests the time required to release the brakes was lost).

Test No. 2 consisted of passing the first ramp at a speed of 35 mi. an hr. with the ramp energized and with a clear single indication.

Test No. 3 was made by the train passing the second ramp which was de-energized and the brakes were applied by the automatic train control apparatus giving an 8-lb. reduction. There were no brakes set on the engines, and both engines used steam up to the time they were stopped. The train was stopped in a distance of 7,920 ft. in 3 min. and 45 sec. The speed on passing the ramp was 35 mi. per hr. A smooth stop resulted. Test No. 4 was a standing test to determine the brake pipe leakage. This test showed that there was a loss of 7 lb. per minute from 50 lb. The time required to apply the brakes on the rear of the train with a 20-lb. reduction was 55 sec., while the time required to release the brakes on the rear was 2 min. and 40 sec. At this time it was decided that a heavier brake pipe reduction was necessary and the I. E. C. valve was adjusted for a 20-lb. reduction.

Test No. 5 consisted of operating a switch located in the cab so arranged that an equivalent action would be produced on the train control apparatus as if it were operated over a ramp in a de-energized condition. At the time of this test the train was proceeding at approximately 35 mi. an hr. and on the operation of the switch a 20-lb. reduction was made automatically which brought the train to a stop in a distance of 6,600 ft. in 1 min. and 57 sec. In this case, the engine throttles were eased off slightly and a smooth stop resulted. The observers on the caboose stated that all the stops made were found to be smooth at the rear end of the train.



Circuit Diagram Showing Connection of Control Units

Electric lamps to the number of 1,660,000, purchased by the United States Government were inspected by the Bureau of Standards during the fiscal year ending June 30, 1923. Samples of these lamps were tested for candle power and were then subjected to the life test, which consists in burning the lamps continuously until they burn out. In order to reduce the time required for this test the lamps are burned at a higher voltage than their rated voltage, the relation between their life at this voltage and their life at normal voltage being known.

A total of 1,608 samples were thus tested, these consisting of 1,318 vacuum tungsten lamps, 216 gas filled tungsten lamps, and 74 carbon lamps. During this time the bureau also tested about 350 samples representing a number of brands which were submitted to the states of New York and Illinois in competition for state contracts.

The West Roanoke Yard at Night Looking West Toward the Hump from a Point Between Tower No. 4 and Tower No. 5

Norfolk & Western Installs Lights in 15 Yards

System of Flood Lighting Peculiarly Suited to Requirements of Classification Yards

THE Norfolk & Western has just completed the installation of flood lighting systems in 15 yards, including all main line yards. Conditions in the yards vary considerably with the traffic requirements and the size and the shape of the yard, but the type of lighting used is adaptable to all circumstances.

The purpose of the installations on the Norfolk & Western as well as on other roads is to speed up night operations, minimize the damage due to rough handling, decrease the loss from theft and promote safety. The lighting systems as installed are peculiarly adapted to the lighting needs of yards in general and classification yards in particular because they show clearly the location of track, the position of switches and the location of cars in the yard.

The lighting system consists essentially of flood lighting units mounted on platforms on steel towers 70 ft. high. There are from four to eight light units or lamps or projectors, as they are referred to commercially, on each tower, the number of projectors depending upon the size of the area to be lighted. The towers are placed at intervals through the yard, the distance between the towers depending largely upon the number of lights on each tower and the convenience of finding places to put the towers. In some cases, buildings are so located that it has been possible to install a group of lighting units on the roof of a building, coal docks probably affording the best opportunity and this has been done at several points.

Steel Towers

The steel towers used for supporting the flood lighting units are of Bates design and were chosen because they occupy little space, are strong, durable and self-supporting without guys. One of the vertical members of the tower is fitted with steps so that it can be climbed easily by a maintainer. The platform and railing at the top are safety features and make it possible for the maintainer to make lamp renewals easily and to do a real job of cleaning the lighting units when that is necessary.

Each tower stands on a rectangular, concrete base and is bolted to this base with eight 1-in. bolts, each of which is 7 ft. 3 in. long and extends almost completely through the concrete base. The dimensions of the base are 6 ft. by 7 ft. by 8 ft. deep. The edges which are above ground are beveled to prevent chipping. This base is so designed that if the tower and base were placed on the surface of the ground, instead of being imbedded, the tower would not be tipped over by a 50-mile wind.

Electric power is brought to each tower at 2,300 volts and a transformer mounted on the tower is used to change this to 110 volts. All wiring on the tower is carried in rigid metal conduit and weather-proof boxes are used for protecting the switches and fuses. The transformer and emergency switch are located at a point half-way up the tower and the lighting units are placed on the top.

Lighting Units

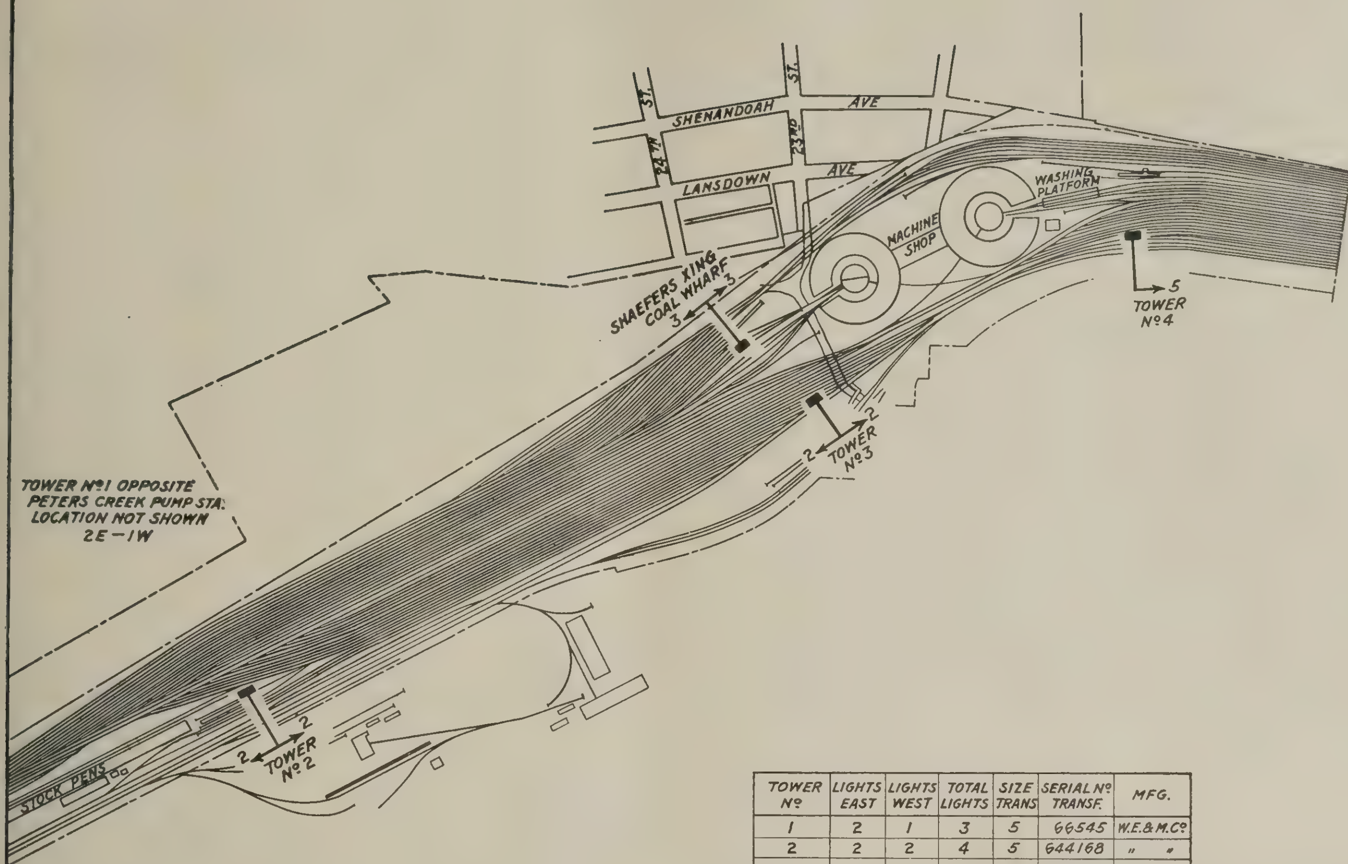
The flood light units or projectors are made of 16 gage, copper-bearing, lead-coated sheet steel and spot welded construction throughout. Each projector contains a 1,000-watt, Type C Westinghouse mazda lamp and the projector housing is ventilated by holes in the bottom of the barrel and door, covered with perforated brass screening, providing ventilation both in front of the reflector and behind it. The inside of the flood light barrel is painted with aluminum bronze to provide diffuse illumination which is effective at short distances from the flood light location; this lighting being distinguished from the illumination obtained from the flood light beam proper, which is generally used with effective ranges varying from 800 to 1,600 ft.

The reflector is 14 in. in diameter, is parabolic and has

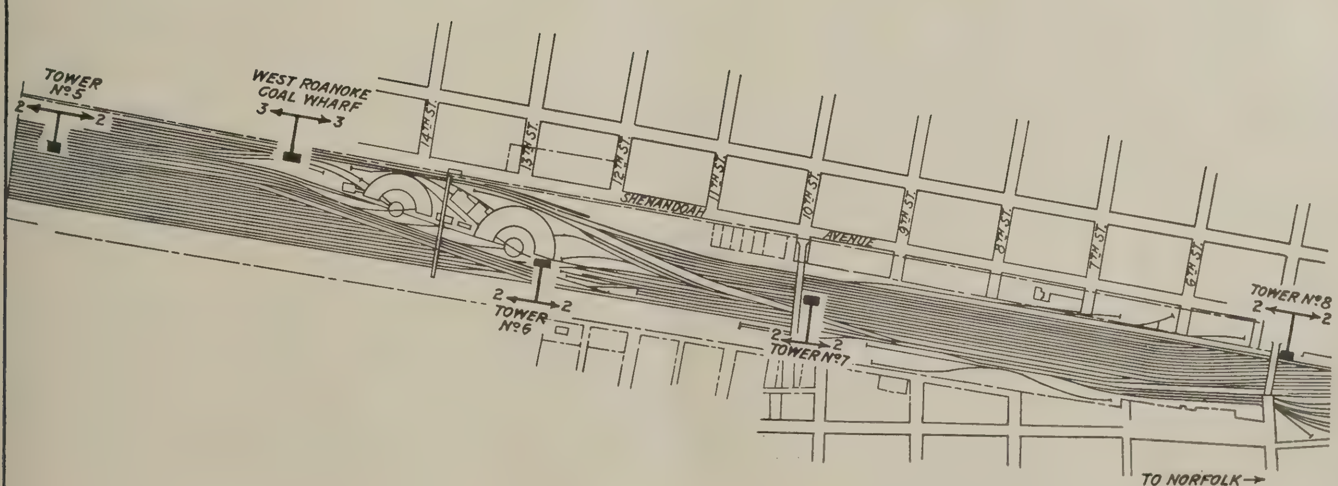
TOWER No.	LIGHTS EAST	LIGHTS WEST	TOTAL LIGHTS	SIZE TRANS.	SERIAL No. TRANSF.	MFG.
1	3	3	6	7½	614839	W.E. & M.Co.
2	2	2	4	5	486761	" "
3	0	6	6	5	665746	" "
4	2	2	4			" "
5	1	5	6			" "
Coal Wharf	0	2	2			*
Elevator	6	0	6			

* Fed from Transf. Bank at Roundhouse

Lamberts Point Yard of the Norfolk & Western Showing Location of Lighting Towers and Direction of Light Beams

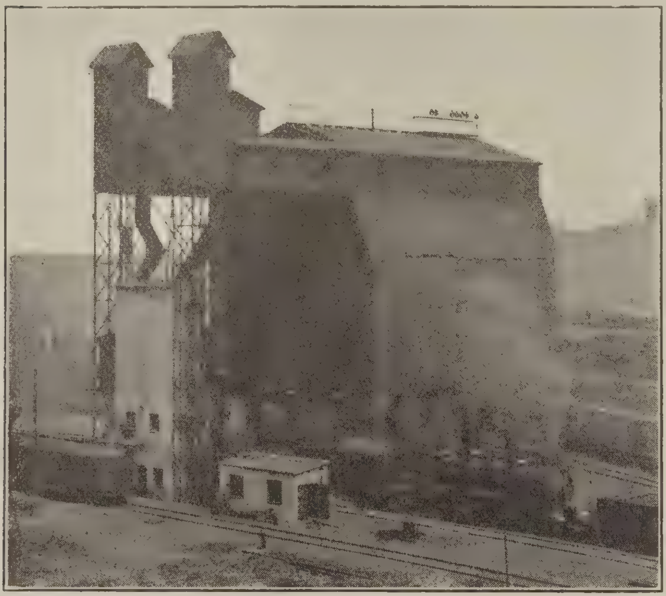


TOWER Nº	LIGHTS EAST	LIGHTS WEST	TOTAL LIGHTS	SIZE TRANS	SERIAL Nº TRANSF.	MFG.
1	2	1	3	5	66545	W.E.&M.Cº
2	2	2	4	5	644168	" "
3	2	2	4	15	654172	" "
4	5	0	5	5	652523	" "
5	2	2	4	5	654163	" "
6	2	2	4	5	654161	" "
7	2	2	4	5	6441196	" "
8	2	2	4	5	644200	" "
Coal Wharf Sh. Xing	3	3	6	Same as Tower Nº 3		
Coal Wharf W. Roke	3	3	6	10	669089	" "



West Roanoke Yards of the Norfolk & Western Showing Location of Lighting Towers and Direction of Light Beams

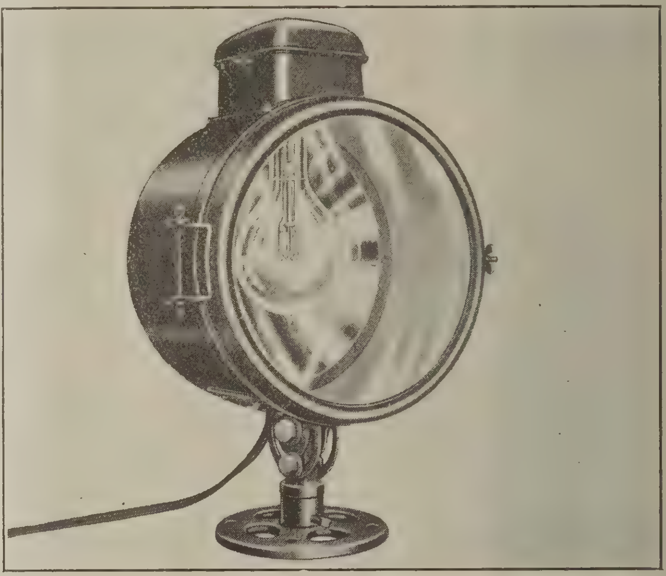
a focal length of 4¾ in. It is made of Golden Glow glass 5/16 in. thick. The outer casting which houses the lamp socket and focusing device is arranged to provide adequate ventilation between the housing proper and the hinged cover, the cover overlapping the housing sufficiently to provide protection from the weather. The hole in the top of the flood light barrel through which the lamp projects is provided with a weather ring casting



A Conveniently Located Coal Dock Provides a Mounting for a Group of Lights and Saves a Tower

with a flange of suitable height to still further protect the lamp from moisture.

The projectors are equipped with Mogul sockets and a focusing device which will accommodate lamps from 750 to 1,500-watt sizes with a PS-bulb. The door has a gasket of rubber tubing and the front glass is mounted in a similar fashion. Leads to the lamp socket have fire and weather-proof insulation. The reflector is 14 in. in diameter and is parabolic, having a 4¾-in. focal length. The bases of the units are made of cast iron. A hinged construction makes it possible to tilt and direct the unit as desired. The projectors were supplied by the Electric Service Supplies Company, Philadelphia, Pa.



One of the Lighting Units

Results

Originally the practice in the hump and gravity classification yards was to hang a red light on the up-grade end of each track of cars. This was superseded by placing individual lighting units on poles along the edge of the yard and at such points between the tracks where it was possible to place them. The new flood lighting system requires a small number of steel towers, but only about half as many poles as required by the individual unit lighting system and such poles as are used are only for the purpose of carrying feeder wires. The cost of the system of flood light is probably about the same as the cost of a

The West Roanoke Yard at Night Looking West from Tower No. 6

system of individual pendant lights; the flood lighting, however, provides a more uniform light, which is most effective. The power consumption of the flood light method is less, as the light distribution is better and the maintenance cost is less since there are fewer units to maintain, and these units are bunched so that it is necessary to climb only one pole to clean or renew lamps in a number of units.

The lighting is peculiarly effective because the light is thrown horizontally and thus diffused over all of the area to be covered. The tracks are the most apparent things in the yard by virtue of the fact that the reflection of the light from their surface can be seen for a long distance.

A Lighting Tower Supporting Four Units

The system also provides a light by means of which the ends of cars standing in the yard are clearly outlined.

The effectiveness of the system as installed on the Norfolk & Western is probably best shown by expressions from the men who work with it. Practically without exception, all of the switchmen and car-riders have expressed their hearty endorsement. The road men are equally enthusiastic because the system makes it possible for them to see exactly where they are going through the yard and to detect any obstruction, such as a car which may have been placed too close to a switch.

The light is surprisingly uniform and from the standpoint of speeding up operation is proving a great help, because the car-riders can see exactly how far they must go before reaching the end of the track of cars. This increased speed of operation is still more apparent where it is necessary for a locomotive to move a cut of cars into one of the tracks against the grade. Although the cars already standing on the track are a considerable distance away, the switchman and engineman are able to see them and to maintain a relatively high speed instead of groping or feeling their way in the dark. In this connection it has been pointed out by the claim department that the greatest amount of damage to equipment is caused by imperfect judgment of speed and distance. The flood lights make it possible for the switchman or car-rider to determine both the speed and distance almost as accurately as is possible in the day time. As a preventive against pilferage, flood lighting is regarded as being of great value.

When first installed, objections were raised in several cases because of the assumed blinding effect of the lights. This proved to be largely a result of curiosity. The men, unaccustomed to the brightness, stared at the lights and, of course, suffered a temporary impairment of vision. They soon discovered, however, that if they gave their attention to their work rather than to the light, they had no difficulty. Now the placing of dimmers on the switch engine headlights has been suggested because there is plenty of light in the yards for the engineman to see ahead and the light from the locomotive headlight tends to be a hindrance rather than a help.

The 15 lighting installations on the Norfolk & Western were planned and installed by C. H. Quinn, chief electrical engineer. Most of them have been in operation for two or three months. The following tabulation shows the installations that have been made:

Lower Portion of a Lighting Tower Showing Top of Concrete Base and Steps for Climbing Tower

Point	No. of Towers	No. of Projectors
Lamberts Point	5	32
Crewe	7	28
Lynchburg	3	10
West Roanoke	8	43
East Radford	4	15

Shenandoah	4	14
Bristol	1	7
Bluefield	8	43
Norton	2	7
Williamson	6	34
Kenova	2	8
Portsmouth	10	50
Columbus	6	26
Clare	2	5
Hagerstown	2	4
Totals	70	326

As a whole, the lighting systems can be considered a valuable aid and productive of increased efficiency. While in this instance the Norfolk & Western has simply adapted a practice which came into prominence in other industrial fields during the war, it has made its installations complete and has built for the future in a characteristic manner.

General Electric Gets New $1,000,000 Order for Paulista Railway

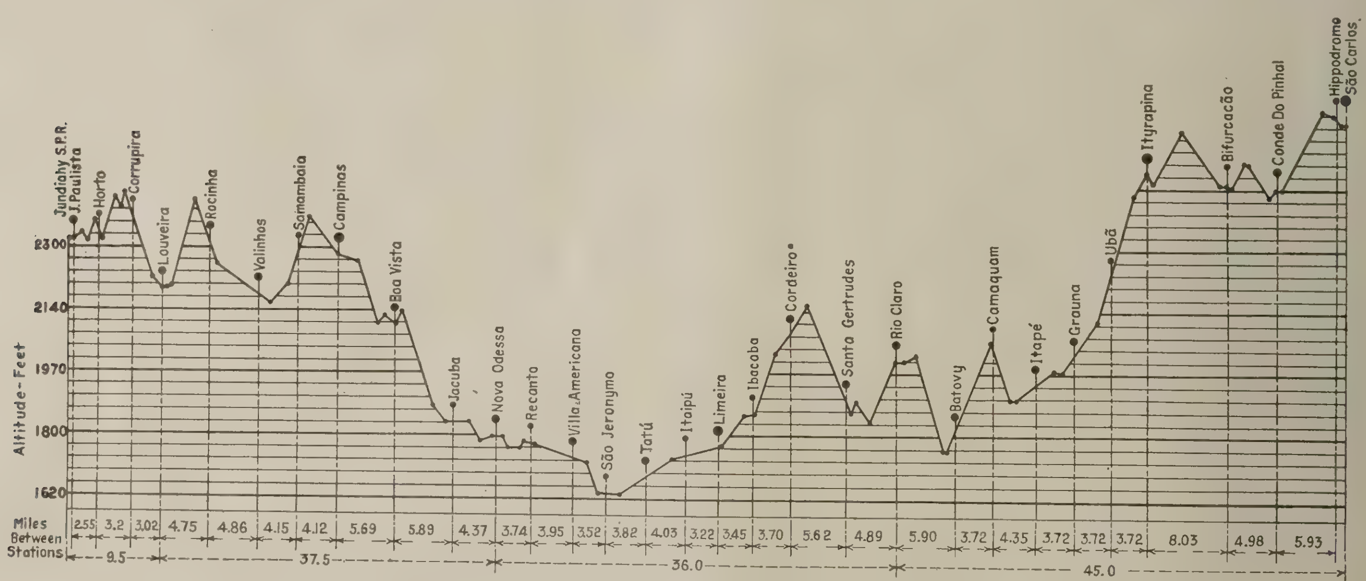
Orders for new equipment totaling about $1,000,000 for electrifying 35 additional miles of the Paulista Railway, Brazil, have just been placed with the International General Electric Company. This extension constitutes part of the additional electrification contemplated when the first contract with the International General Electric Company was closed in 1920, providing for 28 miles of double-track electrification, and will bring the total electrified mileage up to 63 miles, starting at Jundiahy and extending north to Tatu. This is approximately half the total electrified mileage originally planned and further extensions are expected.

Included in the order, just announced, are five 62-ton 3,000-volt, d.c. switching locomotives, a complete sub-station of 4,500 kw. ultimate capacity with motor-generator sets, step-down transformers, switchboards, switch gear and other auxiliary equipment and overhead line material and transmission for the extension.

The original contract called for 12 electric locomotives (eight freight and four passenger), a 4,500 kw. sub-station and transmission for the first 28 miles. This equipment went into service about October, 1921, and has been operating with success. It runs from Jundiahy to Campinas.

Scarcity of coal and the necessity of using wasteful wood-burning locomotives, coupled with steep grades, has been the principal factor in the decision to electrify; the heavy traffic has also been an important factor—in 1918 275,000,000 ton-miles were handled from Jundiahy to Cordiero.

The portion already electrified has indicated substantial savings, while with the completion of the extension more than double the tonnage formerly handled is expected to be hauled with ease. The Paulista is the most important railroad in South America which has thus far adopted the direct current system for electrification. Power is being supplied at 88,000 volts 60 cycles by the Sao Paulo Light & Power Company which will be converted at the sub-station for train operation.



Profile of the Main Line of the Paulista Railway Between Jundiahy and Sao Carlos

A High Carbon Welding Metal

Welding has proven its value in railroad applications not only in maintenance, construction and repairs but also as a reclamation medium particularly on low carbon steel parts. The reclaiming and maintenance of high carbon steel parts such as buffer castings, frog points, steel tires, etc., have somewhat suffered due to the fact that a suitable welding metal was not generally available.

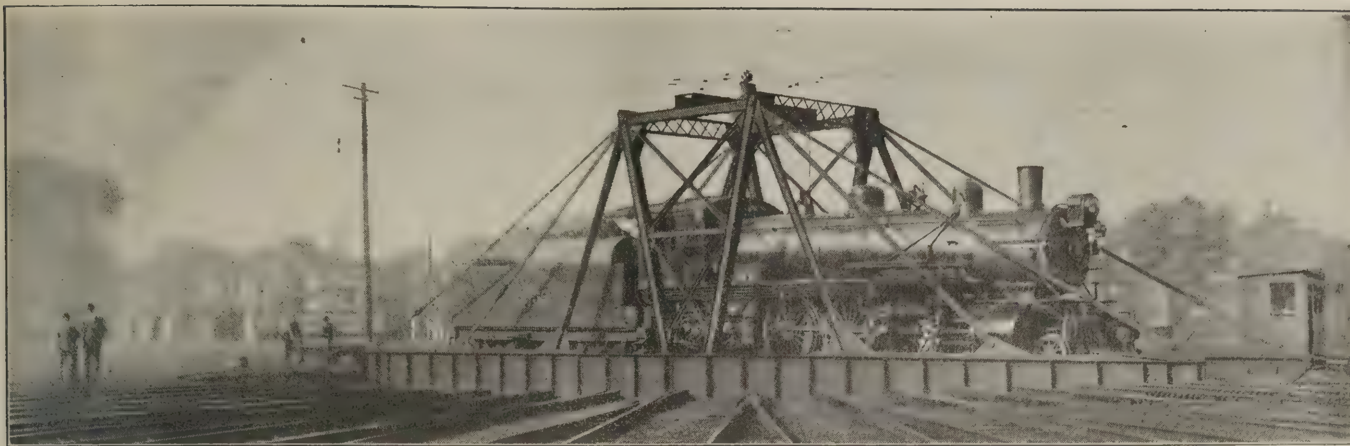
The Page Steel & Wire Company, Bridgeport, Conn., has perfected a welding metal, the carbon analysis of which is practically 1 per cent, for welding high carbon parts by either the oxy-acetylene or electric arc process.

The principal application of Page high carbon welding rods and electrodes is for the building up of worn surfaces where a high resistance to abrasive wear is desired.

Tests of Weld Deposits on .42 Carbon Steel

Original metal—		
Carbon	.42	
Scleroscope	35	
Two layers of weld metal—	Carbon	Scleroscope
Outer surface of deposit	.63	38
At a depth of $\frac{1}{16}$ in. from top	.56	37
At a depth of $\frac{1}{8}$ in. from top	.57	33
At a depth of $\frac{3}{16}$ in. from top	.46	34

The table shows a typical result of weld deposits when made on a steel .42 carbon content indicating wearing qualities that are even more than equal to the original material.



Turntable at Minneapolis, Minn. Equipped with Friction Drive Tractor

Foolproof Tractors for Balanced Type Turntables

Great Northern Installs Outfits Which Cannot Be Injured by Adding Weight or Reversing Motor

SEVERAL turntable tractors have recently been installed by the Great Northern which are so designed that it is practically impossible for a careless operator to injure them. In cases where the design includes a reversing motor it is not uncommon for the operator to use the reverse for stopping the table or to throw the motor into reverse when it is running at practically full speed. To avoid the necessity for balancing the turntable the operators often resort to the practice of loading down the tractor and sanding the rail in an effort to obtain the kind of operation that is obtained by twin-span tables equipped with two large motors. Either of these practices means heroic treatment for the motor and sooner or later results in the burning out of the motor.

Fig. 1—Side View of Tractor Cab Showing Control Lever and Motor Starter

Construction

The new Great Northern tractor is so designed that it is practically impossible to pile weights on the tractor, and even though it were done and the rail sanded, the only effect it would have would be to cause the drive to slip. Furthermore, the tractor drive is so arranged that stopping is accomplished by throwing the control lever into reverse and accordingly no damage can be done by any number of sudden reversals.

A side view of the operating cab is shown in Fig. 1. The cab is mounted directly over the driving gear. The motor starter and the operating lever can be seen through the open door. The starter is a two position starting compensator and the motor is a 15 or 25 hp. squirrel cage type induction motor running at 1,200 r. p. m.

The drive is exposed for inspection by lifting the floor boards of the operating cab as shown in Fig. 2. C is a fiber cone pulley or wheel, which is driven through the flexible coupling B by the motor A. This pulley has a 7-in. face, an outside diameter of 21 in. and an inside diameter of 11 in. There is a bearing on each side of the pulley.

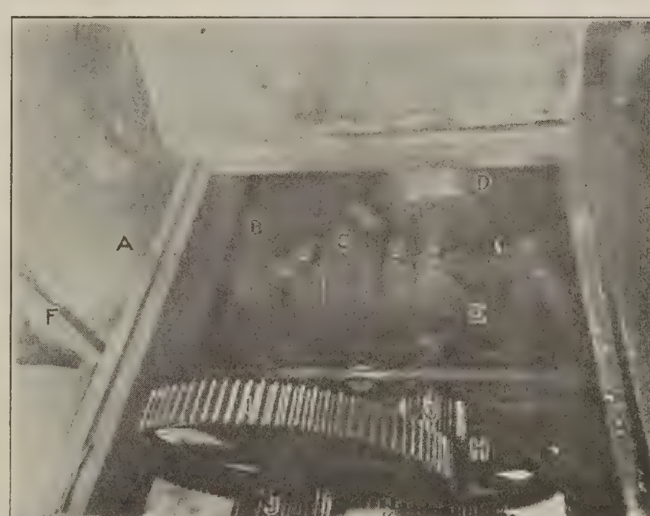


Fig. 2—Flooring of Cab Raised to Show Driving Mechanism

E and D are iron pulleys which are keyed by a spline or feather key to the counter shaft, which is keyed rigidly to

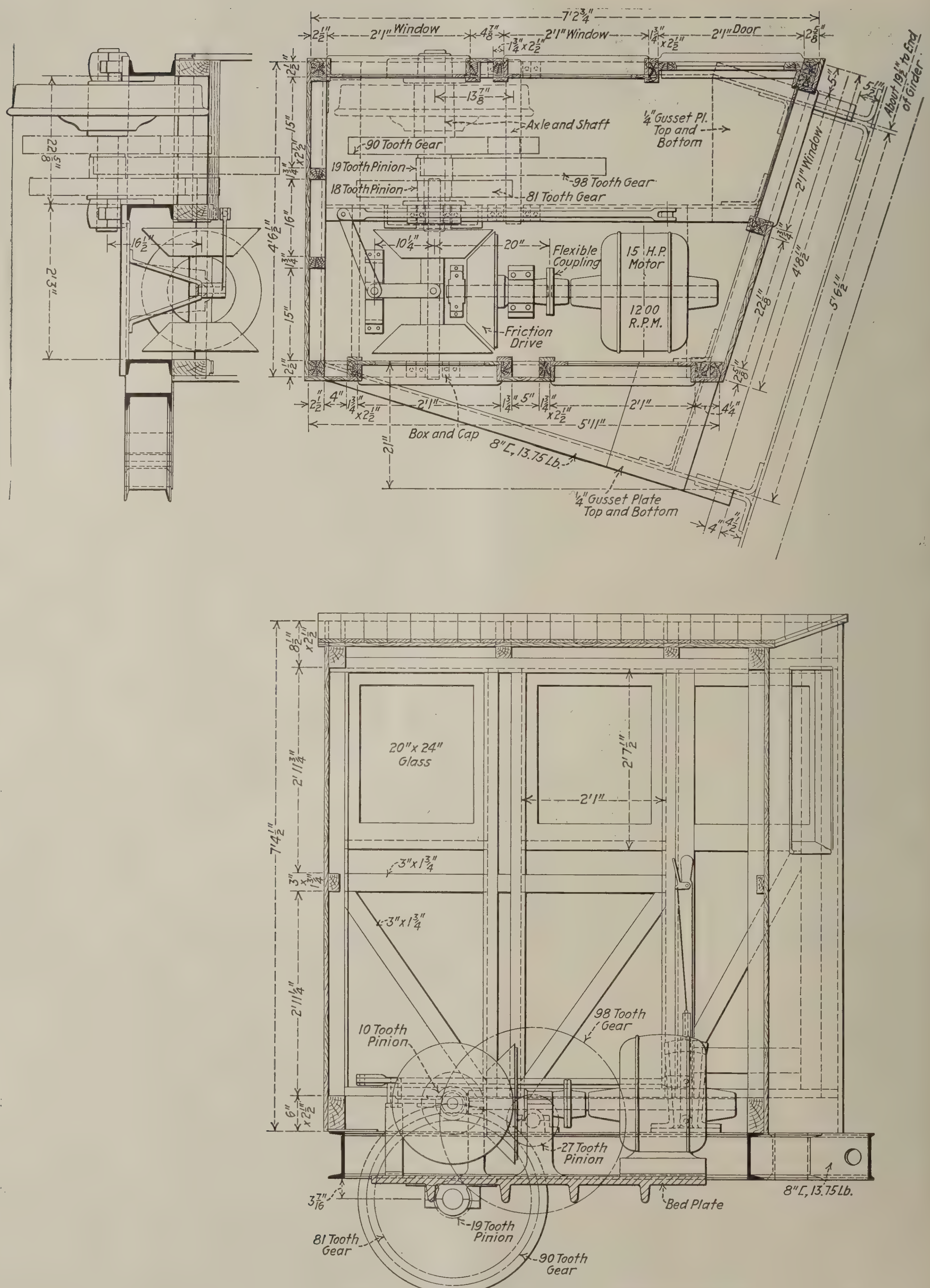


Fig. 4—Some Details of Tractor Construction

the pinion G. Movement of the operating lever F causes the two iron pulleys D and E to slide back and forth on the counter shaft so that either D or E engages with the fiber pulley C. This causes the counter shaft to rotate in one direction or the other and the motion is carried through triple reduction gears to the driving axle.

The operating levers and the cones are so designed

Fig. 3—Mounting Two Gears on the Axle Make a Narrow Cab Possible

that a normal man cannot exert enough pressure on the lever F to overload the motor sufficiently to damage it in any way.

The gears H and K are both mounted on the axle. K is rigidly keyed to the axle and H is free to rotate on it. This arrangement of gears permits the use of a narrow cab as shown in Fig. 3, which does not have the tendency as a wider cab to lean toward the center of the turntable pit.

Operation

When the table is to be moved, the operator first starts the motor by means of the compensator. The operating lever is held normally in the neutral position by springs and the motor runs free. If the operator then wishes to move forward so that the tractor pushes against the table he moves the operating lever F, Fig. 2, in that direction. This causes the pulley E to engage with C and the table starts, gradually picking up speed until there is practically no slip between the two pulleys. When he wishes to stop he simply pulls the operating lever back into the reverse position. This causes pulleys D and C to engage, and as they are rotating in opposite directions they work effectively as a brake. If the operating lever is held in this position long enough, the table of course will reverse.

As might be expected, the pulley C wears, but the wear is not excessive. The pulley has an iron frame on which a number of ⅝-in. fiber discs are bolted. As the discs wear down the smallest one is taken off and one of the largest size is added. In this way a disc is worn from a diameter of 21 in. to a diameter of 11 in. before it is taken out of service.

Motors running at 900 r. p. m. have been tried for this service but have been found unsatisfactory on account of the slower speed of the friction wheels. With 1,200 r. p. m. motors no serious difficulty of design was encountered. Both the operators and the roundhouse foremen who are dependent on these tractors are enthusiastic about the service they provide. Six additional tractors of this type are now being built and will soon be in service.

The construction of the tractor is shown complete in Fig. 4. Details of design may be obtained from E. Marshall, electrical engineer, Great Northern Railway Co., St. Paul, Minn.

A reward of $100 was offered by the management of the Chicago, Rock Island & Pacific to the officer or employee of the road who by its efforts makes the largest saving by eliminating waste in labor or material during the month of August.

Left—Interior of Second and Third Class Car, Norway. Right—Interior of Third Class Tourist Car

Battery Repair Methods on the C. B. & Q

Overhauling Concentrated at Aurora Where "Overway" Track System Expedites Handling of Batteries

DURING the past three years the Chicago, Burlington & Quincy has completely changed its system of overhauling car lighting batteries; this has resulted in more efficient service and a marked economy of operation. As it was necessary to maintain a battery room at the car shops at Aurora, Ill., for overhauling batteries on cars undergoing general repairs, it was decided to centralize all battery work at that place. This not only permitted a reduction in the total number of men employed on such work but left the men at the passenger terminals free to give more attention to running repairs, thus bringing about greater operating efficiency for the car lighting service.

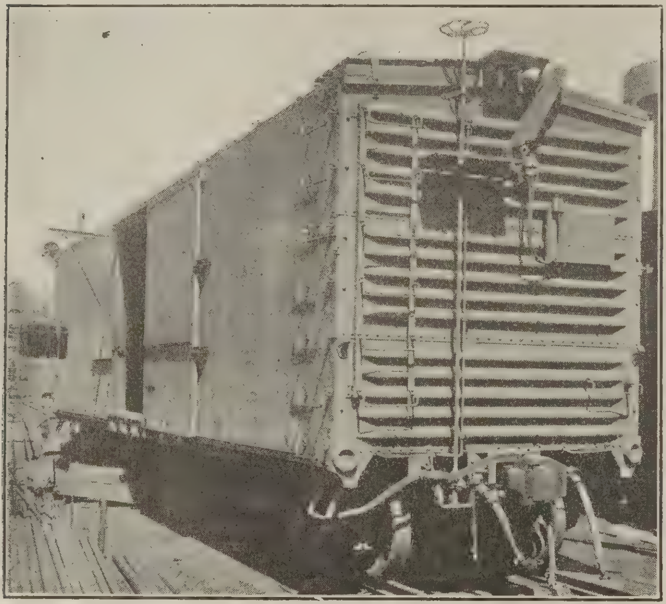


Fig. 1—Freight Car with Special Train Line Connections and Crane Equipment

Special Car Used for Shipping Batteries

A special car was equipped for shipping exhausted batteries from the several terminals to Aurora, and sending back the repaired batteries. A modern freight car was fitted with a special bracket crane on the door frame; this with a ½-ton chain hoist and battery tongs facilitates the loading and unloading of cells. A special truck, so constructed that the cells can be easily picked up, is used inside the car to bring the cells to the door. About 162 two-cell crates can be placed in the car when the batteries are placed close together on the floor at the two ends of the car. The car can be loaded or unloaded in about two hours. When a loaded car arrives at the Aurora shop the "Overway" track system is extended into the car; it is supported by a steel horse, as shown to the right in Fig. 2.

Until recently the Burlington has used the 64-volt, 3-wire head-end car lighting system, with the turbo-generator in the baggage car, on all main-line through trains. Every third car in connection with this system is provided with a 64-volt set of batteries. The road is now equipping a number of the one-night run trains with 32-volt axle light systems. Suburban trains operating between Chicago and Aurora are lighted from a small turbo-generator located on the top of the boiler of the locomotive between the sand dome and the cab; no batteries are necessary with this system of lighting. In addition to the batteries on Burlington equipment, the batteries on all Pullman cars not equipped with axle generators, and which are regularly assigned to the Burlington, are maintained at the Aurora shop.

Overway System Eliminates Manual Lifting of Batteries

An ingenious system of "Overway" track, together with chain hoists and clamps, expedites the handling of batteries and eliminates considerable labor. This track system, as shown in Fig. 3, is supported from overhead beams. The track is constructed of special steel channel sections supported by hangers from above, so arranged that a small eight-wheel car can run inside the channels. The track lay-out consists of three tracks the length of the building, together with one cross-lead that can be extended into the car, as shown in Fig. 2. Two of the runs lengthwise of the building extend over battery benches used for storage and charging, while the other lead extends over the center bay where the battery overhauling, washing and re-assembling is done. The little cars, to which the chain

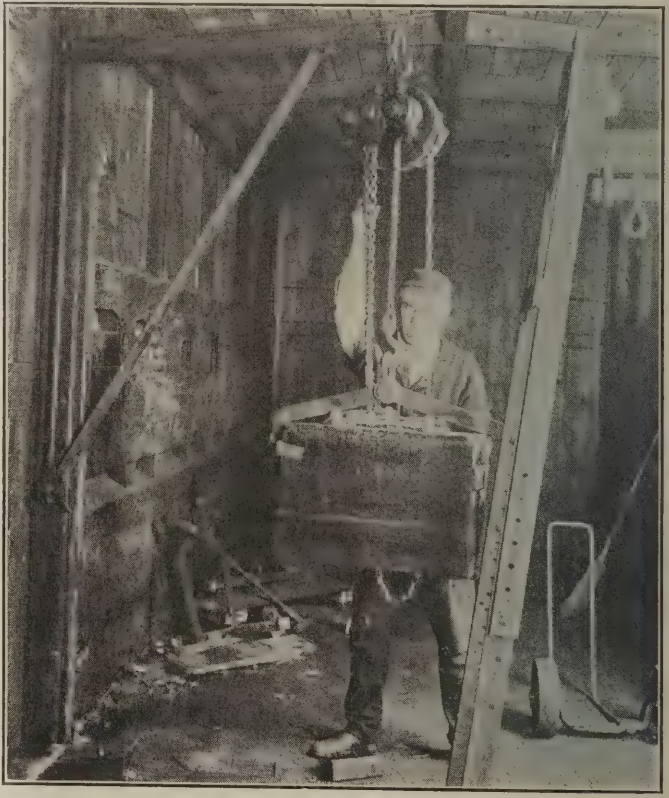


Fig. 2—On the Left is the Bracket Crane for Loading or Unloading Batteries. On the Right is the Extension of the Track System from the Battery House

hoists are attached, can be switched from one track to another by switches operated by pull chains. With the two-way switch one end of a four-foot section of the rail is simply swung from one connection to the other; the three-way switch, shown to the left of the post in Fig. 3, consists of a block of three short sections that can be lined up for any desired move.

Five sets of ½-ton chain hoists, as illustrated in Fig. 3, are used to lift the battery and carry it about the shop. Special tongs or clamps are used to pick up the batteries, one size being made for the two-cell and another for the three-cell crates.

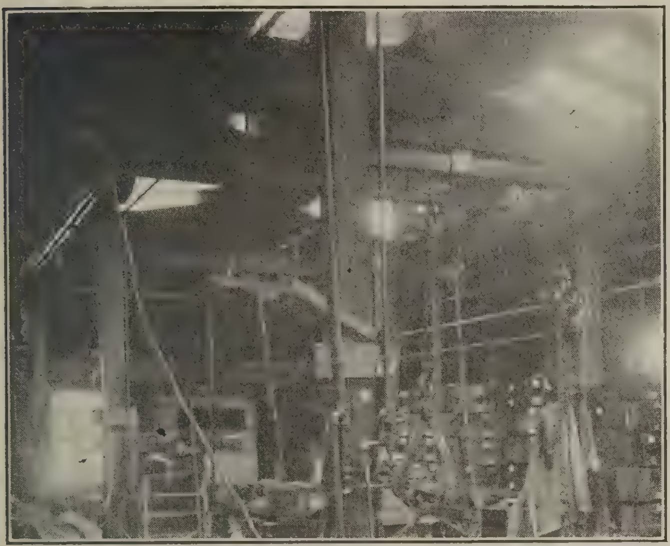


Fig. 3—The Over-Way Track System, Together with the Switching Apparatus, is Supported from Overhead Beams

Progress of Battery Through Shop

When a car load of batteries requiring general repairs arrives at the shop the "Overway" track is extended into the car, as shown to the right in Fig. 2. The small truck is used to haul the battery to the door where it is picked up by the clamp and chain hoists. The battery, by means of the "Overway" system, is then placed on the floor at one side of the room, as shown in Fig. 4. At this point a deep galvanized iron cover fitted with a steam connection is placed over the battery and the steam soon loosens the wax holding the battery cover, which is then removed.

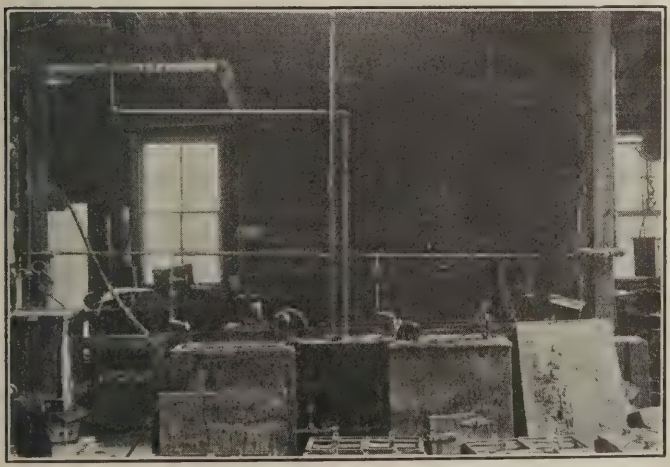


Fig. 4—A Corner of the Room Showing Wax Vats and Storage Space in Foreground

The battery is taken to the washing bench shown in Fig. 5, either by means of the "Overway" cranes or by the small hand truck. The plates are removed from the cell by the double hook shown hanging on the end of the bench, the hooks being slipped into the terminal holes. The plates and tanks are cleaned and washed in the usual manner; water pipes with hose connections extend down to the table from overhead. On the left of the bench, as shown in Fig. 6, are the valves for both air and water which lead to a special tank washing arrangement, consisting of coils of pipes with small holes, placed below the level of the top of the bench and arranged to wash either a two or three-cell crate. A press for straightening the plates, operated by an air-cylinder, is shown to the right in the rear. The cells are reassembled, using such material as has been reconditioned for service, i.e., tanks, plates, separators, etc.

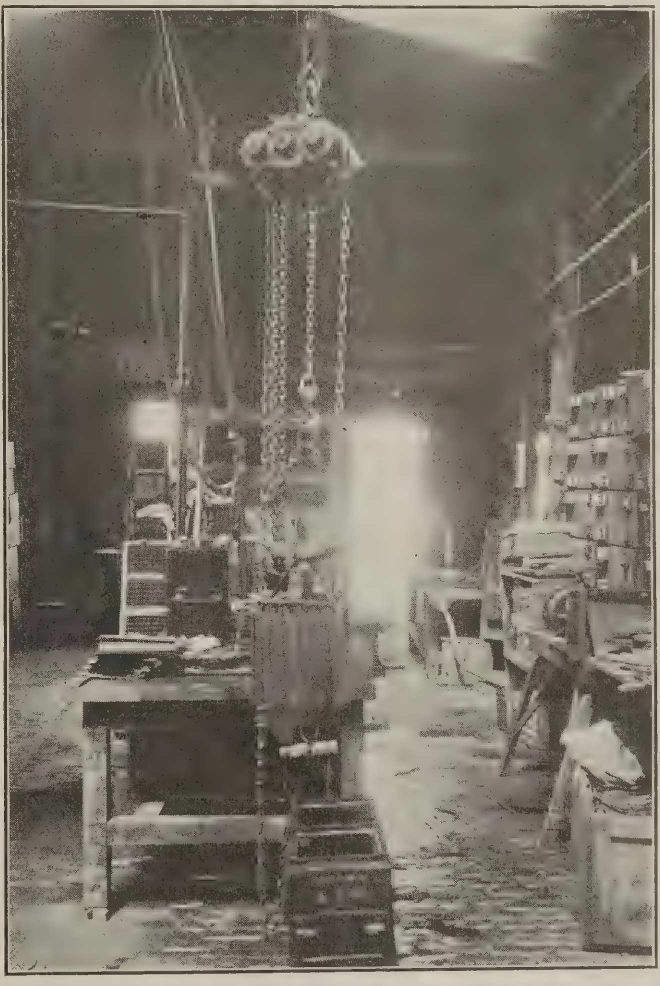


Fig. 5—Battery Washing Bench. Note Special Clamp for Holding Canvas Strip That is Used to Hold the Assembly of Plates When Lowering Them into Tank

The tanks are floated into the crates in wax, and this wax must be warmed to remove the tank; this is done by a large steam heated cover which is placed over the crates. The tank is then pulled out of the crate by placing a block of wood across the top and using the clamp and hoist as shown in front of the window, to the extreme right of Fig. 4. The majority of the tanks in service are lead, however, and as they become worn out they are being replaced in sets by the rubber jars.

The repair of the lead tanks is done at the other end of the shop. The tanks are straightened and repaired by fitting them over a box mandrel which is covered with sheet iron; this is shown in Fig. 7. After repairing, each tank is tested by filling with water and allowing a small amount of steam to condense in the water, thus causing a

Fig. 6—Battery Washing Bench and Air Press for Straightening Plates

vibration which locates any leak quickly. On the box below the tank is shown the slotted crate for holding the battery plates while making repairs; oxy-acetylene torches are used to make these repairs.

After the crates and tanks are ready for service the tank is floated in the crate in hot wax, which when hardened

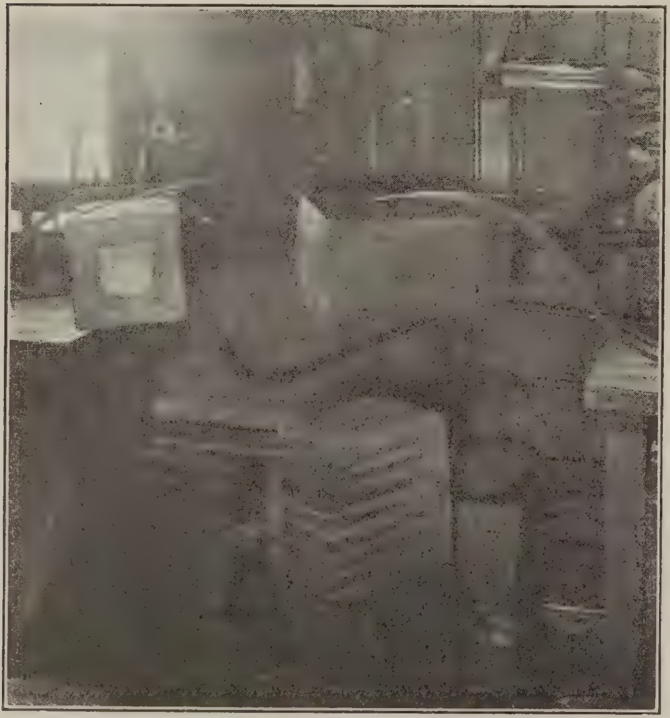


Fig. 7—The Lead Tanks are Repaired over Mandrels

makes a tight unit of the crate and tank. The crates are then piled up ready for assembly, as shown in Fig. 6.

New material or overhauled parts are used when the cells are assembled. They are placed on the charging benches where the cell is filled with electrolyte that has been tested. After charging and testing, the covers and connectors are bolted and burnt on. The battery is then numbered, dated and marked ready for service.

Charging Equipment

A motor-generator set is used as a source of power for charging batteries, the generator having a capacity of 177 amp. at 85 volts normally. A charging board, Fig. 8, consisting of six panels of the Allen Bradley make was placed in service recently. It includes a voltmeter and an ammeter for the total generator load. Ammeters on each of the six separate circuits indicate the rate of charge or discharge. In addition to the set of carbon pile rheostats each panel has an overload and a no-load automatic release

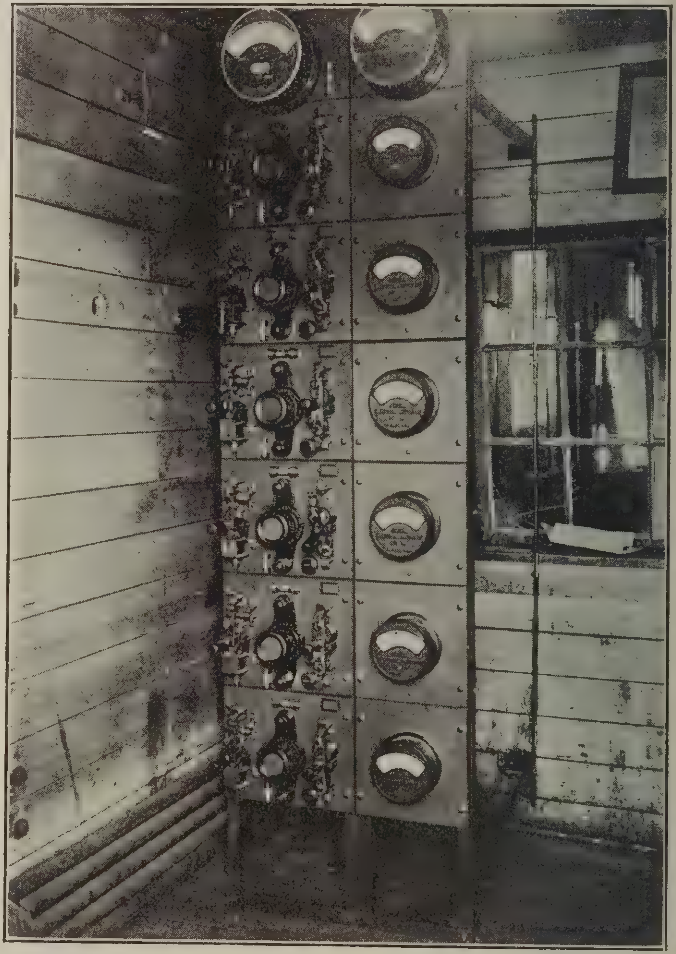


Fig. 8—Switchboard Used in Battery Charging

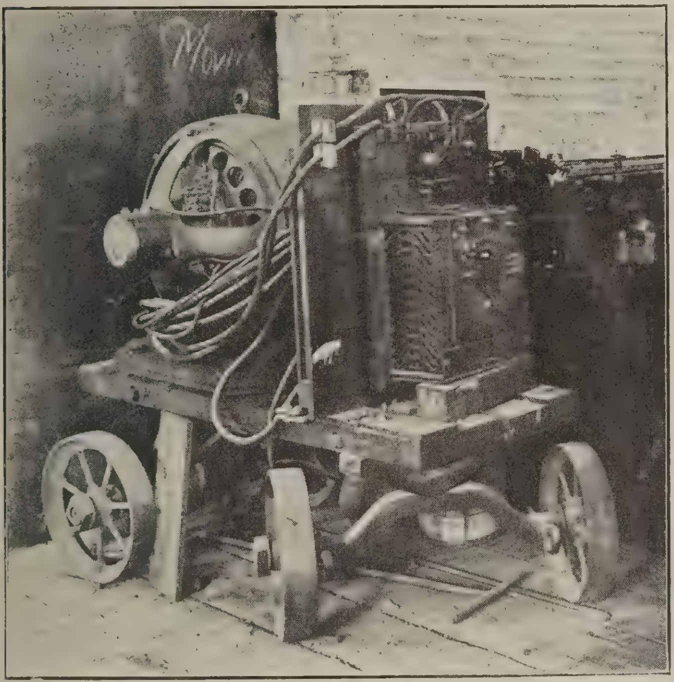
circuit breaker. The circuit breaker is so designed that with the handle thrown up the circuit is on charge but with the handle thrown down the circuit is on discharge through the carbon pile resistances. The six charging circuits terminate in long flexible leads, as shown in Fig. 3.

Good Results Accomplished

With a force of four electricians, including the lead working foreman and three helpers, this shop is overhauling on an average of 24 sets of batteries a month; a set consists of 16 crates of two-cell capacity, or its equivalent in three-cell crates. One month in particular, 31 sets of batteries were overhauled. This work is done under the direction of L. S. Simms, electrical foreman at the Aurora shop.

Portable Emergency Motor

A means for driving shop machine tools in an emergency is not often needed, but when it is wanted the need is usually great enough to warrant having one always ready as a stand-by. Such a motor drive, shown in the illustration is used in the shops of the Pere Marquette at Grand Rapids, Mich. It consists of a 15-h. p., 250-volt d. c. Fairbanks-Morse motor with a full load speed of 975 r. p. m., a double pole carbon break circuit breaker with an overload trip and a starter mounted on a four-wheeled cart. A two-conductor cable is connected to the



The Portable Equipment Used on the Pere Marquette

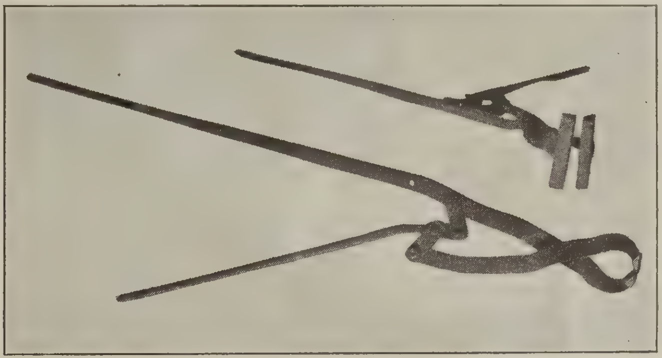
circuit breaker panel which is long enough to reach one of the several power outlets located at convenient intervals on the walls or supporting columns of the shop.

Most of the machine tools in the shop are arranged for group drive. There are 12 groups of machines, each driven by one motor and there are from 6 to 12 machines in each group. When one of the group motors fails or gives indications that it may fail, the emergency motor is trundled to the proper position and is belted to the group shaft in place of the regular motor. The plug on the end of the portable cable is connected to the nearest outlet and the motor started, the whole operation usually requiring only a few minutes. To hold the emergency motor in position it is only necessary to check the wheels of the cart with wedge shaped blocks.

If no emergency unit were available, repair of the damaged motor would, of course, be started at once. A motor failure, however, without the emergency drive would make it necessary to find other work temporarily for from 6 to 14 men and this can seldom be done to good advantage. Furthermore with the emergency motor in operation, plenty of time is available to overhaul the damaged motor thoroughly and thus avoid undesirable temporary repairs.

A Battery Plate Trimmer

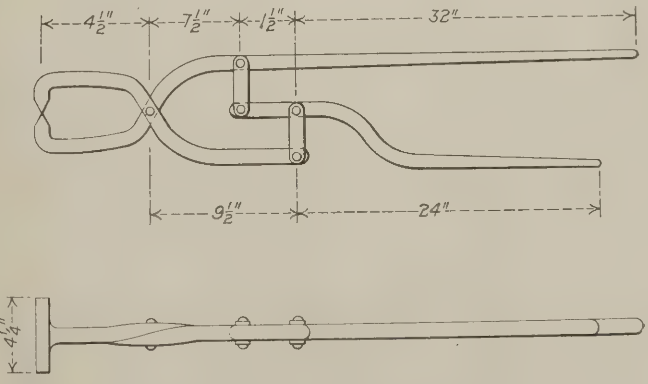
One of the well known disadvantages of the soft lead battery plate is the continued growth in service causing shorts and other internal troubles to the cell. In many car



Two Views of the Plate Trimmer

lighting battery repair shops this extra growth of metal is sawed off with a hack saw, while other roads use a chisel or heavy knife.

The battery plate clipper shown in the illustrations was



Sketch Showing Dimensions of Trimmer

designed and made by the car lighting forces of the Chicago & Western Indiana and has been used in the Chicago coach yards for several years. This clipper has been loaned to several other roads to be copied and the idea is published here to pass it along to other readers.

The tongs and handles are forged out of ½ in. by 1½ in. iron. The jaws with forged and ground edges are welded to the tongs. It was all very easy to design the device this far but in order to get enough force on the edges to cut the plates readily a compound lever arrangement as shown was designed. The links are made of two pieces of ¼ in. by 1 in. strap iron. It is essential that the bolt or rivet at the main pivot, X, be aligned properly and kept tight so as to make the cutting edges meet exactly.

Hire Out to Yourself

Some day
When you feel gay
And think you deserve a raise
For your valuable services,
I tell you what to do.
You put the shoe on the other foot
And hire out to yourself,
Just for a day or two.
Put yourself in your employer's place
And keep tab on what you do.
Let's see.
You were late this morning.
Only ten minutes?
That's true, but whose time was it?
You took pay for it.
Therefore you sold it.
You can't sell eight hours of time
And keep a part of it—
Not unless you give short measure.
How about that work
You had to do over?
You're not paid to be careless,
You're paid to do work well,
Not twice over,
But once, that's enough.
Then do it right
The first time you do it.
That's what you would do
If you worked for yourself.
Hire out, then, to a man named "You."
Imagine it's up to you
To meet the payroll,
Then see what a difference it makes
In the point of view.
Say, try it once
For a day or two.

Rockland Island Magazine.

"I'm Your Job"

Take care of me!

You had better take care of me.

Perhaps you don't think much of me, at times, but if you were to wake up some morning and realize you did not have me, you would start that day with an uneasy feeling.

From me you get food, clothing, shelter, and such luxuries as you enjoy.

If you want me to—badly enough—I'll get you a twelve-cylinder automobile, and a home on the lake front.

But I am exacting. I am a jealous mistress. Sometimes you appear hardly to appreciate me at all. In fact, you make slighting remarks about me at times, and neglect me.

Considering the fact that you need me not only for the material things of life, but spiritually, as well, I wonder, sometimes, that you neglect me as you do.

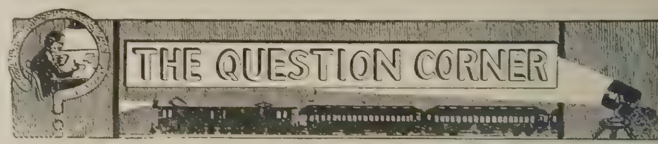
What if I should get away from you? Your happiness would flee, for a time at least, and your friends would wonder what sort of fellow you were; and your wife would worry, and your bank account dwindle.

So, after all, I'm pretty important to you.

I'm your Job!

Cherish me. Take good care of me, and I'll take good care of you.

Courtesy adds to any service.



Answers to Questions

1. *What is the highest temperature that is considered safe for the operation of lead storage batteries?—S. C.*

2. *What is meant by the temperature coefficient of resistance?—R. F.*

3. *It is desired to run a 10 hp. pumping motor from a 110-volt circuit, the source of power being 2,000 ft. away from the motor. If a line drop of 10 per cent is allowed what size wire will be required?—R. E.*

* * *

Safe Operating Temperature for Lead Storage Batteries

1. There can be no definite point assigned above or below which it would be injurious to operate a lead storage battery. In general it may be said that high temperatures tend to produce sulphation and the higher the temperature the greater the tendency to sulphate. A limit of 110 degrees F. has been established not so much from the actual requirements of battery operation but more from a case of necessity under summer conditions. A battery operated at even 90 or 95 degrees F. continuously will tend to sulphate more readily than one operated at a lower temperature.—H. B.

* * *

The Temperature Coefficient of Resistance

2. In answer to the August question as to what is meant by the temperature coefficient of resistance, the resistance of a conductor varies with the temperature, and the percentage of change per degree centigrade, or per degree Fahrenheit in some English works, is defined as the temperature coefficient of resistance. The temperature at which it is measured must be defined, as the coefficient varies at different temperatures, it varies with different substances, and it varies even in the same substance, with its condition. For instance, it differs in crystallized selenium and amorphous, although it be of the same purity and at the same temperature. When defined in the Fahrenheit scale it is 5/9 of the centigrade value.

All metals have a positive coefficient, i. e., the resistivity rises with increase of temperature. But this is not necessarily true of alloys, some of which have a zero coefficient. Notable examples of this are manganin and constantan. The coefficients of practically all "non-conductors" at

ordinary temperatures are negative, i. e., the resistivity becomes lower as the temperature rises, which gives rise to many troublesome problems in insulation at high temperatures, such as in dust settling from hot gases by the Cottrell process.—D. N. L.

Resistivity of Metals
(Microhms per cm.[3])

	−160°	0°	18°	100°	Temp. coeff. at 0°
Aluminum	0.81	2.8	2.94	4.13	0.0040
Antimony		36.0	40.5		0.0041
Bismuth		55.55	119.0	160.3	0.0035
Cadmium (drawn)	2.72	7.0	7.54	9.82	0.0042[5]
Copper (drawn)	0.49	1.58	1.78	2.36	0.0039
Calcium		7.5	10.5		
Cobalt			9.71		0.0033[5]
Gold	0.68		2.42	3.11	0.0037
Arsenic		33.3			
Iridium			5.3		
Iron			9–15	16.8	0.0062
Iron (wrought)	5.4		13.9	18.8	0.0058
Lead (drawn)	7.43	19.0	20.8	27.7	0.0039
Lithium		8.4			
Magnesium		4.35			0.0038
Mercury		94.07	95.57		0.00072
Molybdenum			4.1[2]		0.0050[5]
Steel			19.9	25.6	
Nickel	5.9		11.8	15.7	0.0062[5]
Osmium			9.5[3]		
Palladium			10.7	13.8	0.0035[5]
Platinum	2.4[4]	9.0	11.0	14.0	0.0037[5]
Potassium		6.64			
Rhodium			6.0		
Silver	0.56	1.50	1.65	2.13	0.00377
Sodium		4.74			
Strontium			25.0[3]		
Tantalum			14.6		0.0033[5]
Tellurium			21.0[3]		0.0040
Thallium		17.6			
Thorium			40.1		
Tin (drawn)	3.5	10.0	11.3	15.3	0.0043
Tungsten (annealed)		4.42	4.81	6.65	0.0051[5]
Zinc	2.2	5.6	6.1	7.9	0.00365

[1] At −183°. [2] At 25°. [3] At 20°. [4] At −204°. [5] From 18° to 100°.

The values at low temperatures are mostly Lee's; those at 18°, Jaeger and Diesselhorst's; those at 0° from a table compiled by Watt's, "Laboratory Course in Electrochemistry," while those at 100° are from various sources.

Alloys[1]

	−160°	0°	18°	100°	Temp. coeff. at 0°
German silver[2]		26.6		27.6	0.0003
Nichrome		95.5			0.00044
Brass	4.1		6.6		0.0010
Constantan			49.0	49.1	−0.000050 to +0.000050
Manganin[3]	43.13		43.50	42.1	0.000002 to 0.000039[4]
Phosphor bronze			5–10		
Woods alloy			31.25		

[1] Temperature coefficients from "Standard Handbook."
[2] 62 per cent. Cu, 15 Ni, 22 Zn.
[3] 84 per cent. Cu, 4 Ni, 12 Mn.
[4] Most samples cf manganin have a zero temperature coefficient from 30° to 40°C.

Table Showing Physical Constants of Various Substances

Note: The table given is taken from Liddell's "Metallurgists' and Chemists' Handbook," published by McGraw-Hill Book Co.

* * *

Line Drop in Motor Operation

3. A line drop of 10 per cent is allowed, and since the voltage is 110, the drop will be 10 per cent of 110, or 11 volts.

As one electrical horsepower is 746 watts ten horsepower will be 7,460 watts, and in order to find the current required in the circuit to furnish this power the following formula may be used—

current = watts ÷ voltage

Substituting the values for watts and voltage, the current is found to be 7,460 ÷ 110 or 68 amps. From the formula R = V ÷ C in which R is the line resistance of 2 wires each 2,000 ft. long, V, the drop in voltage in the line, and C, the current to operate the motor, it is found that the resistance of the line is

R = 11 ÷ 68 or 0.162 ohms for 4,000 ft.

of conductor, or 0.04 ohms per 1,000 ft. From a wire table it will be found that the No. 0000 has a resistance of .048 ohms per 1,000 ft. so that it will be necessary to use the next larger size.

This problem shows the importance of using high voltages for transmitting power any long distance such as this, for had a 440 volt circuit been installed, a wire 1/16 the sectional area could have been used and still kept within the same percentage line drop.

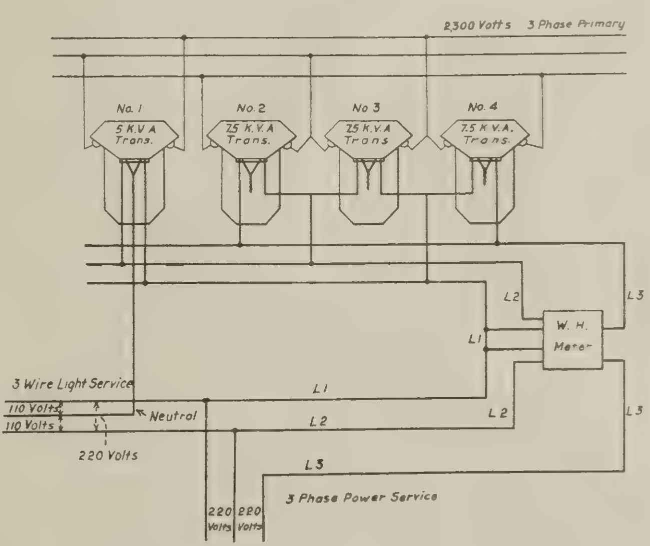
In computing wire sizes it is best to refer to a table on allowable currents, and in this particular instance it will be noted that No. 0000 wire with weatherproof insulation will carry 312 amperes without overheating. When this size wire is used on the 68 ampere circuit, of course the line will not be overheated.

* * *

Questions for September

1. *Will a 3-wire light service connected to a 3-phase watt-hour meter read a correct load? If you will note in the sketch, L 1 at the meter has only a shunt tap. Will the current consumed between L 1 and the neutral of this light service be registered on the meter?*

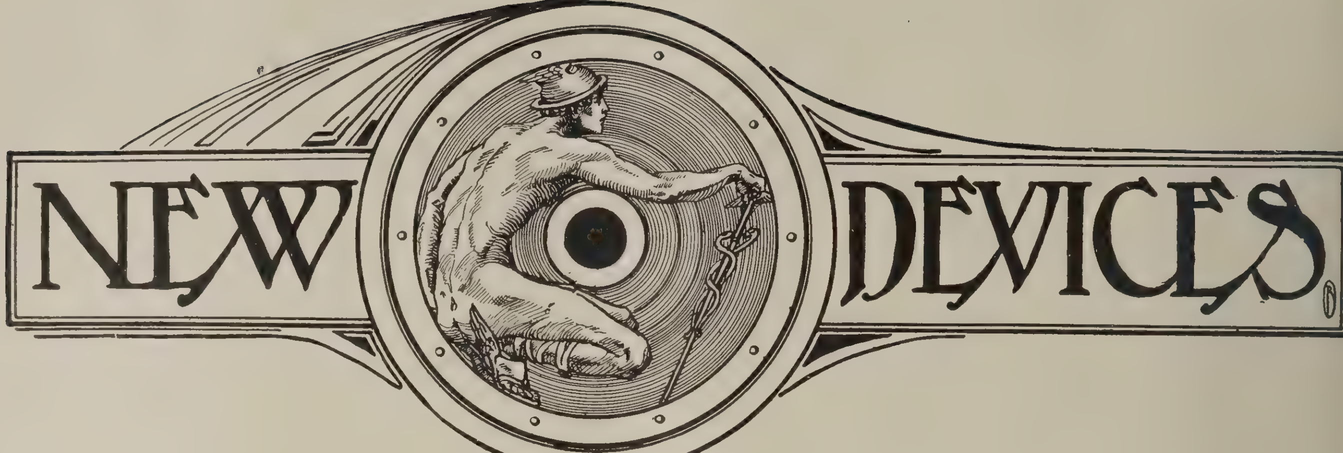
2. *If the same service was connected to L 2 and L 3, will the meter register a load on L 1? What I mean, is the dial on a 3-phase meter calibrated to read the load consumed on L 1 when L 1 is used for a potential tap? I think there are two-load coils in a 3-phase meter; if a load of 30 amperes is taken on L 2 and also on L 3 and nothing on L 1 but the voltage, what would be the result? Would it also read a load of 30 amperes on L 1?*



Wiring Diagram Referred to in Questions for September

3. *In the transformer bank shown, transformer No. 1 is banked as one with transformer No. 3. Wouldn't it be proper to connect neutral tap on transformer No. 3 with transformer No. 1? If fuse on transformer No. 1 blows out, wouldn't it be possible to get 220 volts on light service if circuit was unbalanced?*

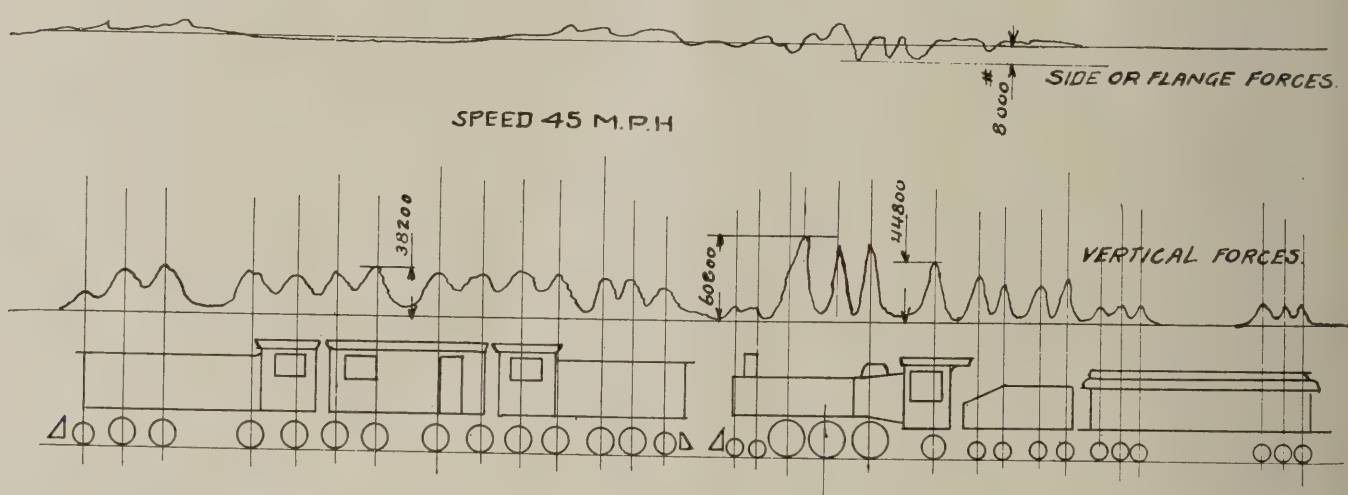
4. *What would be the results if a 110 volt, 2-wire watt-hour meter were connected on 220 volts, if the shunt coil didn't burn out? Would it read fast or slow?*



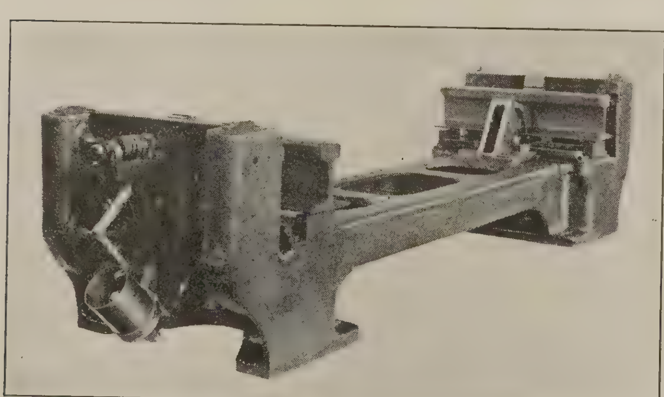
Determining the Amount of Wheel Impact on Rail

An interesting device known as an otheograph, which is in effect a test tie for measuring simultaneously the vertical and transverse thrust or impact of a wheel on a rail, has been recently developed by the General Electric Company, Schenectady, N. Y., and a number of these ties are being installed on the company's test tracks at Erie, Pa. The instrument shows by graphic records the effect of each separate wheel of a locomotive or car on each of the two rails.

These otheograph ties may be installed in place of the regular ties, either singly or several grouped together on curves or tangent track. Provision is made for the use of two different springs for recording the vertical load, one having a deflection of about ⅛ in. for each 25,000 lb. of axle loading, and the other spring having the same deflection for each 50,000 lb. of axle loading. The springs are designed for a maximum deflection of ⅜ in. The springs for recording the transverse thrust have deflection of about ⅛ in. for each 20,000 lb. The deflection of the spring is recorded through a lever having a ratio of 8 to 1, the record being traced on paper wrapped around a revolving cylinder similar to an engine indicator. The operating mechanism provides for moving the recording cylinder on any number of ties simultaneously so that as many records may be taken of each wheel on each side of the locomotive as there are ties that are grouped together.



Experimental Record Made of a Test on C. M. & St. P. Electric and Pacific Type Steam Locomotive Coupled Together. Figures Show Approximate Stresses in Pounds.



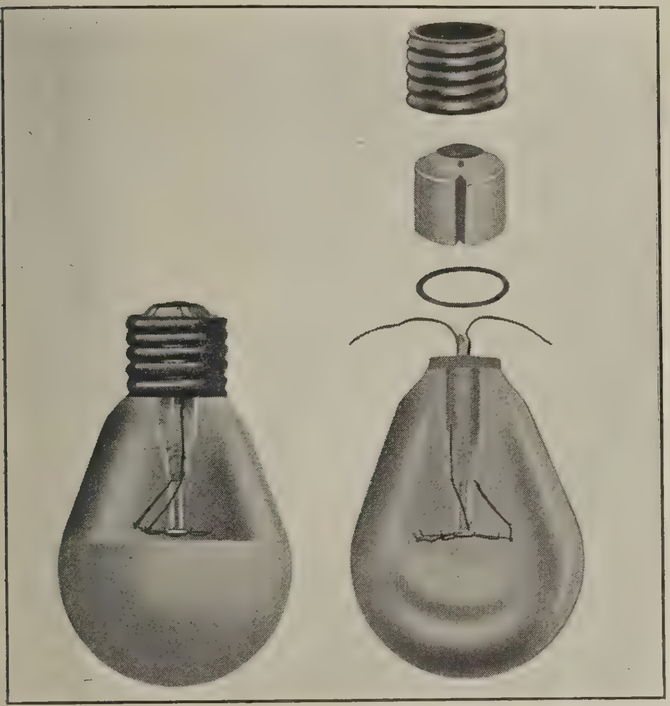
A General View of the Otheograph Tie

Theft-Proof Lamp

An electric lamp known as the Kulp theft-proof bulb, designed to prevent loss from theft, has been developed by Lester Kulp of Chicago, Ill. It is a standard lamp in that it fits into any standard socket and is used in ex-

actly the same way as any ordinary Edison base lamp.

One of the two contacts is located in the center of the base as is the case with a standard lamp. The other contact is a brass ring secured to the bottom of a porcelain plug. The ring is in contact with, but is not fastened to, the outside brass shell or screw. The plug has a groove which is filled with plaster of paris, lightly holding the brass shell in place. The plug will not pull out of the brass shell, and the plaster of paris prevents the plug from turning without turning the shell.



The Kulp Theft-Proof Lamp

After the lamp is screwed into the socket, an extra turn breaks the plaster of paris seal so that the lamp can turn freely in the shell always maintaining electrical contact. The shell, however, cannot be turned in the socket after the seal is broken. The shell is spun over the ring and screws up so close to the socket that fingers or tools cannot grasp it.

When the lamp is burned out, it is removed for replacement by breaking the bulb. A ring is etched on the glass to cause it to break off evenly without danger of shattered glass. The manufacturer plans to sell the lamp at the regular standard prices. They are made in various sizes for all standard voltages.

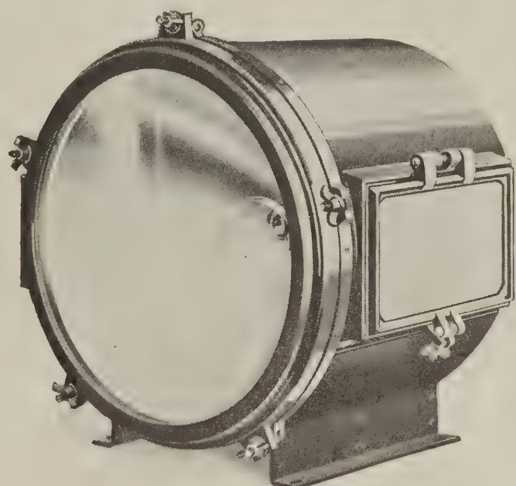
Locomotive Headlight With Sealed Metal Reflector

A locomotive headlight case with a hermetically sealed silver-plated copper reflector has been developed by the Pyle National Company, Chicago, Ill. A standard 18-in. x 9-in. parabolic reflector is used which is spun from heavy gauge sheet copper, the inside surface being prepared for the quadruple silver plating by a grinding and polishing operation. After plating, the silver surface is burnished and lacquered.

The focusing device is attached to the back of the reflector and is designed to maintain the seal at all times. Use of the device is necessary only in making the focal adjustment for the initial lamp application, unless, on renewal, a lamp is applied which does not conform to specifications. The reflector assembly is held tightly against a gasketed joint in the door frame casting by bronze screws.

The case is fabricated from 16 gauge copper-bearing steel or Armco iron. The case is protected on the outside by two coats of flexible black baking enamel and on the inside by the application of an aluminizing preparation. A machine finished cast aluminum-alloy door frame forms the front of the case and a slot-hinged door ring which is also a machine finished aluminum-alloy casting is sealed against a heavy gasket by the tightening of five wing nuts on hinged bolts. When the door is open it swings freely on the hinge, but when it is closed the hinge does not interfere with the action of the bolts and wing nuts. The front glass is made of clear, convex, heat resisting glass, and is held and sealed against the door ring gasket by means of bronze clamp screws.

Lamp replacements are made by loosening the bronze ring nuts and swinging open the front door. This construction makes the fitting of front glasses convenient and avoids the necessity of breaking electrical connection or disturbing the focal adjustments for renewing lamps. The headlight is made in four case styles to comply with requirements for numeral display frames.



Pyle-National Headlight No. 20-C-300-N Having Illuminated Numeral Display Frames with Parallel Sides

Bench Type Twist Drill

A bench-type twist drill grinder has been developed by the Gallmeyer & Livingston Company, Grand Rapids, Mich. The grinder is driven by a self-contained ½-hp. motor, enabling it to be placed in any position in the shop tool room where most convenient. It has a diamond truing device and the diamond is furnished as part of standard equipment for dressing the wheel. The holder is automatically placed in the right relationship with the grinding on the wheel so that it is close enough to grind the drills accurately and at the same time the stop makes it impossible to bump the front of the holder into the grinding wheel. It is made in two sizes for drills from No. 52 to ¾ in. and for drills from ⅛ in. to 1½ in.

The motor can be driven from the lighting circuit or power lines, the motors being either d. c. or a. c. single-phase or polyphase for standard voltages.

General News Section

The French Battery & Carbon Company has moved its Chicago office to 11 South Desplaines street.

The Lake Erie & Western has authorized the construction of improvements and additions to its shops at Lima, Ohio, to cost approximately $150,000.

The West Virginia-Kentucky Association of Mine Mechanical and Electrical Engineers will hold its third annual convention at the Frederick Hotel, Huntington, W. Va., October 19 and 20.

The Roller Smith Company, New York, has recently issued illustrated bulletin No. 10, describing in detail its new line of small size voltmeters and ammeters designed especially for use on radio control panels.

Examiners for the Interstate Commerce Commission have recommended that the Staley System's plan to build 1,240 miles of electric railway in Arizona, New Mexico, Colorado and California be not approved.

The Electrical and Industrial Exposition will be held at the Grand Central Palace, New York, October 17 to 27. The exhibits will occupy three floors of the big building, the third floor being given over to government displays.

The Moffat Tunnel Commission will receive bids until September 12 for the boring of a main tunnel 16 ft. by 24 ft. and a pioneer tunnel 8 ft. by 8 ft. under James Peak, in Brand county, Colo. The tunnels will be approximately 6 miles long.

The Norfolk & Western has been authorized by the Interstate Commerce Commission to install automatic control on one passenger locomotive division between Shenandoah, Va., and Hagerstown, Md., in lieu of the installation originally required.

A crew of four men built a freight car in the shops of the Texas & Pacific at Marshall, Tex., recently in 5 hr. and 55 min. The crew was one of eight engaged in a contest in building standard 36 ft. stock cars. The maximum time consumed in the contest by four men in building one of the cars was 6 hr. and 40 min.

The Missouri Pacific recently dedicated its new hospital at St. Louis, Mo. The building is six stories high, of brick and stone construction and contains 300 beds and six operating rooms. It also has ample sun parlors, dressing rooms, serving rooms and dining rooms. The building cost $1,000,000, which was furnished by the Missouri Pacific Hospital Association.

Terre Haute, Indianapolis & Eastern (Electric)—jointly with the Interstate Public Service Company, the Union Traction Company and the Indianapolis & Cincinnati Traction Company, plans the construction of a large freight terminal at Indianapolis, Ind. The construction of the building will be undertaken at once in order that it may be completed within the next four or five months.

The state of California has adopted a motor vehicle law, effective August 31, which provides that operators of all motor vehicles carrying passengers for hire, school omnibuses and motor trucks carrying explosives or inflammables must bring their cars to a complete stop before crossing the tracks of any steam railroad or of any interurban or suburban electric railway. The penalty is a fine of not exceeding $500 or imprisonment not exceeding six months or both.

The Waters Arc Welding Corporation, on August 7, was granted a patent on arc current welding transformers and plans are being made for establishing a national organization. The number of the patent is 1,464,145. The company will add to its present line, which consists of alternating current arc welding machines and supplies, a new line of direct current welding machines, both of the grid and motor generator types, as well as gas-driven welding machines.

The Union Pacific has issued an accurate and attractively printed railway map of the United States. This map is somewhat of a departure from the conventional railway map in that it shows curves where curves exist and the area served by the railway company's lines is not distorted to appear larger proportionately than the rest of the country. The map is printed in colors and on the back are printed many half-tone illustrations of places of interest along the Union Pacific together with descriptive matter.

The Brenner-Moxley-Mervis Company, Chicago, has been organized by local interests to engage in the production of copper rods and drawn copper wire for electrical power transmission. The company has bought eight acres of land on Kedzie avenue as a site for its plant, the first unit of which is now under construction. N. T. Brenner, of the American Insulated Wire & Cable Company, is president of the new company. William J. Moxley and Geo. T. Moxley are vice-presidents, N. T. Brenner, Jr., is treasurer, and Meyer B. Mervis is secretary.

Electric Railway in Central Africa

The following statement by the Belgian Minister of Colonies of the conditions under which the Leopoldville-Matadi Railway (Central Africa) will be electrified has been received by the Department of Commerce from Consul General H. M. Morgan, Brussels:

"It will be the first important railroad in Central Africa to be electrified. We possess along the river, throughout the whole region, waterfalls and rapids capable of producing considerable power. Researches made by the railroad company have enabled them to establish that more than 100,000 horsepower may be readily obtained for the use of the railroad, and that in addition there exists unlimited reserves for extension. For the electrification of the railroad 30,000 horsepower will suffice, at least in the

beginning, and we will thus replace the coal which has to come from Europe and which is very expensive, by natural resources existing on the spot and which up to now have not been utilized. It is estimated that the money required for electrification will be 150 million francs ($6,750,000 at the present rate of exchange). The gage of the line is at present 75 cm. (29½ in.). It is impossible for technical reasons to electrify the line efficiently unless the gage is made at least 1.06 meters (41¾ in.). Consequently the widening of the lines will have to be undertaken before any other work is begun."

Program of Illuminating Engineering Society at Lake George Convention

At the 17th annual convention of the Illuminating Engineering Society which will be held at Lake George, N. Y., September 24 to 28, the following tentative program will be presented:

Monday.....Morning:
- Registration.

Afternoon:
- Address of Welcome.
- President's Address.
- Survey of the year's work—Report of General Secretary.
- Year's Progress in Illumination—by Committee on Progress, F. E. Cady, chairman.
- Levels of Illumination in Inspection of Bearings—by D. P. Hess and Ward Harrison.
- Power Station Lighting—by Raymond A. Hopkins.

Evening:
- Entertainment—Informal Dance.

Tuesday.....Morning:
- Thoroughfare Lighting Symposium.
- Pageant Street Lighting—by S. G. Hibben.

Afternoon:
- Boat Trip with Session of Committee Reports; Motor Vehicle Lighting Regulations—by Committee on Motor Vehicle Lighting, Clayton H. Sharp, Chairman.
- Illuminating Engineering Nomenclature and Photometric Standards—by Committee on Nomenclature and Standards, E. C. Crittenden, Chairman.
- Progress of the Tentative Code of Luminaire Design—by Committee to Cooperate with Fixture Manufacturers, M. Luckiesh, Chairman.

Evening:
- A Night of Light and Color.
- Address—by Maxfield Parrish.
- Light—The Designer—by M. Luckiesh.
- Outdoor Spectacular Lighting Display.

Wednesday..Morning:
- Determination of Daylight Intensity at a Window Opening—by H. H. Kimball.
- Utilization Factors for Daylight—Professor H. H. Higbie.
- Principles Governing Utilization of Daylight in Roof Fenestration—by W. S. Brown.
- Lighting for School Buildings—Preliminary Draft of Revised Code—by Committee on Lighting Legislation, L. B. Marks, Chairman.

Afternoon:
- Motor Trip and Lunch in Woods.

Evening:
- Lighting of Steel Mills and Foundries—by W. H. Rademacher.
- Meeting Exacting Lighting Conditions—by A. D. Curtis and J. L. Stair.
- Railway Car Lighting—by G. E. Hulse.
- Effect of Dirt and Dust on Lighting Efficiency—by E. A. Anderson.

Thursday—Morning:
- Research Problems—Report of Committee on Research—Dr. E. F. Nichols, Chairman.
- Visibility of Radiant Energy—by K. S. Gibson and E. P. T. Tyndall.
- The Colorimetry and Photometry of Daylight and Incandescent Illuminants—by Dr. I. G. Priest.
- Effect of Color of Light on the Working Eye—by C. E. Ferree and G. Rand.

Noon:
- Council Luncheon.

Afternoon:
- Accessories for Color Lighting—By M. Luckiesh.
- Production and Growth in Plants Under Artificial Illumination—by Professor R. H. Harvey.
- Plant Growth by Artificial Lighting—by Professor Hugh Findlay.
- Unit Costs of Industrial Lighting—by Davis H. Tuck.
- Testing Colored Material for Fastness to Light—by H. S. Thayer.

Evening:
- Banquet.

Friday—Morning:
- Section Development Day.
- How to Make the I. E. S. a Truly National Body—by D. McFarlan Moore.
- Discussion of Matters Pertaining to Section Development.
- Discussion of "Chapters on Light" prepared for high school physics text-books—by R. W. Shenton.

New Swedish Electric Road

The electrification of the most northerly railroad in the world has just been completed. This has a length of 285 miles, and is the second longest electric road in the world, being surpassed only by an electrified stretch of the Chicago, Milwaukee & St. Paul Railroad in the United States. The Swedish road links the iron ore mining districts of Lapland with the Svartoen and Narvik ports, and before being completely electrified, had carried 75,000,000 tons of iron ores valued at nearly $260,000,000.

Contracts Let for South Eastern & Chatham Electrification

Contracts have been awarded to the English Electric Company and the Metropolitan-Vickers Electrical Company, Ltd., respectively for motors and control gear for the electrification of a portion of the suburban lines of the South Eastern & Chatham section of the Southern Railway (England). The contract calls for 508 traction motors each of 300 hp. The lines to be electrified include all suburban services within a 15-mile radius of Charing Cross, London.

French Plan Railway Across Sahara Desert

France is planning to span the Sahara desert with a railway line with the idea of developing the resources of the region and those of the territories to the south, ultimately joining up with the British railways in the Gold Coast and Nigeria colonies, making a through route from the Mediterranean to the Gulf of Guinea. The French, it is said, plan to have the Sudan ultimately as a cultural and economic entity with their nation. The proposed line would be 1,750 miles in length and the barrenness of the country would present some serious obstacles, among them the provision of water supply and the arrangement of habitable settlements for railway employees.

Personals

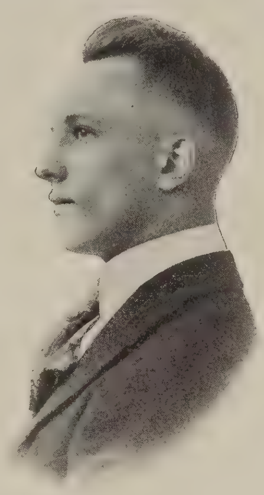
Dr. Thomas Addison, often called the father of the electrical industry in the West, has retired at his own request as Pacific coast manager of the General Electric Company, and will be succeeded by J. A. Cranston, formerly Northwestern manager.

Dr. Addison has been with the company for 33 years, and has held his present position since 1892. He was born in Courtland, Michigan, and was graduated from Bellevue Medical College with the class of 1877. In 1885 he foresook his profession to take employment with the United States Electrical Company of Chicago, and in 1888 he accepted a position as apparatus salesman with the Thomson-Houston Company at that city. When the Western branch of the company was reorganized in 1890 he was selected to go to San Francisco as local manager. Two years later he became Pacific coast manager of the General Electric Company, and this post he has filled for more than thirty years.

Dr. Addison's great contribution to electrical progress has not been confined to the advancement of his own company. He has taken an active part in the upbuilding of other branches of the industry besides his own, and has shown a warm interest in the formation of local tech-

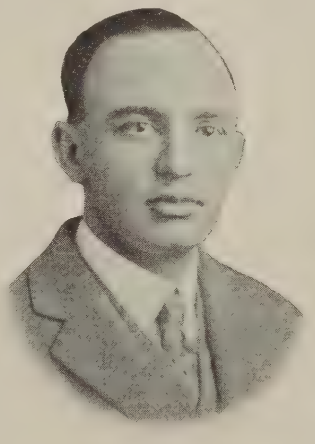
nical and commercial organizations and their development to their present importance. His sympathetic encouragement has been an active factor in the cultivation of such new fields as electric pumping in irrigation or, more recently, the advance of electricity into the oil fields.

J. D. Fischer, formerly connected with the Chicago branch of the Electric Storage Battery Company, has recently assumed charge of the railway business for the Minneapolis branch of the same company. Mr. Fischer started with the company in the manufacturing end of the business in 1915. He was later assigned to the sales division, continuing in that capacity until the participation of the United States in the World War, during which he was in active overseas duty with the Marine Corps. Upon his return from the service he again entered the sales division of the Electric Storage Battery Company, continuing in this capacity in the Chicago branch until his recent transfer to the Minneapolis, Minn., territory, where he will have charge of both sales and special service for batteries in railway service.



J. D. Fischer

Phillip X. Rice, instructor in railway electrical engineering and research engineer at the Pennsylvania State College, has been appointed electrical engineer of the Miller Train Control Corporation, with headquarters at Danville, Ill. Mr. Rice was born in 1892 at Bentonville, Ark., and was graduated from the University of Arkansas in 1916. In 1913 he became associated with the General Railway Signal Company. During the war he was attached to the British Light Railway Forces and also the general headquarters of the American army and was later made chief engineer of power plant construction and operation. In 1921 he became instructor in railway electrical engineering and an engineer in refrigerator car research at Pennsylvania State College, which position he held until his recent appointment.



Philip X. Rice

John F. Cunningham, Jr., has been appointed assistant manager of the production department of the Schenectady Works of the General Electric Company.

Mr. Cunningham was born in Valley Falls, N. Y. After leaving school he entered the employ of the Hoosick Falls Power and Light Company and served that company for two years, doing power station and line work. In 1901, he entered the employ of the General Electric Company in the armature department. In 1906, he was transferred to the turbine section of the production department as production clerk. He was later transferred to the main section of the production department as contract clerk and later as assistant to the production manager, in charge of requisition service. In 1919, he was transferred to the works manager's office in the capacity of special representative.

Trade Publications

Johns-Pratt Company, Hartford, Conn., is distributing an illustrated folder showing the Noark meter service switch and its relation between the power station and the consumer.

The Ivanhoe-Regent Works of the General Electric Co., Cleveland, O., has just issued a new price list, No. 415, and discount sheet No. 416, covering Ivanhoe metal reflectors and fittings for railroad service.

The Reliance Electric & Engineering Company, Cleveland, Ohio, is distributing two illustrated bulletins. One of these describes its type AA induction motors, the second, type AS adjustable speed motors for direct current.

The Okonite Company, Passaic, N. J., is distributing an eight-page booklet entitled, "Splices and Tapes," in which are described the various insulating tapes which it manufactures. The final page of the pamphlet is devoted to directions for making a perfect splice, the various steps being pointed out and an illustration given showing a correctly made joint.

The Sunbeam Electric & Manufacturing Company, Evansville, Ind., has just issued its fifth edition of the "Modern Locomotive Headlight." The book contains 72 pages with numerous illustrations of the Sunbeam headlight turbo-generator parts and assembly. A number of useful tables is also included which makes the booklet of value as a reference.

The Westinghouse Electric & Manufacturing Company has just issued Vol. III, No. 3 of its Electrification Data Series, dealing with the Chilean State Railway electrification. The booklet, which contains twenty pages and is amply illustrated with photographs and drawings, explains the problem that the Chilean Railway officials had to solve and how they solved it.

Transformers.—A booklet on the "Installation and Care of Transformers" and a load value card have been prepared by the Packard Electric Company, Warren, Ohio. Both the booklet and the card are contributions toward getting greater service value and longer life from transformers in use by giving them proper treatment and they should be of real help to the users of transformers. The booklet includes general rules governing transformer installations and instructions for the care of transformers. The card is intended as a guide for the proper fusing of transformers and shows the full load current in amperes for transformers with various kv.-a. and voltage ratings.

Railway Electrical Engineer

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A Word for the Supply Man

Several announcements have been made in these pages of the convention of the Association of Electrical Engineers, which will be held at the Hotel La Salle, Chicago, November 6 to 9 inclusive. The exhibits of the railway supply men constitute an important part of the convention as it is largely through the exhibitors that the railroad men are kept informed concerning the latest developments of equipment. Those who bring exhibits to the convention do so at considerable expense and while they expect that the expense will be offset by the sales which may result from the exhibition of their equipment, it is nevertheless heartening to them to have the members of the association visit their booths and inspect the apparatus. This is true of all exhibitors but to a much greater extent to the exhibitor who comes to the convention for the first time. To be sure, there are not many newcomers in the field of electrical equipment but occasionally some manufacturer does exhibit for the first time and when he does, he should be given every consideration. It is well to remember that he may not be acquainted with the other members of the supplymen's association and he may have a very limited acquaintance among the railway electrical men also. The product which the newcomer has may already be familiar, or it may not; but in any event, he should be accorded the courtesy of a hearty welcome to the growing list of exhibitors.

Eliminating Lost Motion

Unnecessary traveling and duplication of work has been reduced on several railroads by combining the maintenance of telegraph, telephone, signal and electric lighting and power facilities. The combining must be arranged carefully and be limited principally to line work and to simple apparatus. If this is not done the combination may easily do more harm than good, particularly if the apparatus to be repaired may effect the operation of other machinery or equipment. If, however, the combined maintenance work is carefully planned, it will eliminate a large amount of traveling and will often permit the making of repairs more quickly. The efficiency of a well organized combined maintenance force is made apparent when it becomes necessary to repair the damage done by a general storm. Arranging for combined maintenance work is a task which requires diplomacy and a wide knowledge of the maintenance work in other departments, but such arrangements have been made and the subject is one which can profitably be given consideration.

Rail Motor Cars

The subject of rail motor cars is one in which increasing interest has been recently manifested. There are numerous places where equipment of this type meets the requirements in a way which could not be met economically in any other manner. The revenue derived from the operation of steam trains in branch line service usually falls considerably short of the expense involved, with the result that the service is infrequent and unsatisfactory alike to the territory served and to the railroad company.

The advent of motor rail cars has done much to overcome the difficulties in branch line operation and in special cases has been used to improve the service on sections of main line. More frequent service can be given and this can be furnished at a cost which compares more favorably with the revenue derived.

The adoption of any of these cars will add another item to the already lengthy list of maintenance problems for the electrical man. Storage battery or gas-electric cars require their particular maintenance and even on the gasoline operated cars, the lighting is usually electric. This type of equipment bids fair to find extensive application and electrical men should follow the development closely.

Heating Tires Electrically

Electrical heating devices have acquired an important position in railroad work during the past five or six years. Electric welding may properly be considered an electric heating process and probably the railroads and railroad supply companies have done more than any other industry to bring it to its present state of development. It has been used by railroads for 15 years, but it was not until 1917 that its possibilities really began to be recognized.

It is a well-known fact that the heating of buildings is not economically practicable, but electric heat can be so well controlled that it is constantly finding new applications. Practically any desired temperature can be obtained and the heat can be applied to any desired location without providing for drafts or exhaust gases. In some cases the object to be heated is used as a conductor and is heated by virtue of the fact that it has resistance. These characteristics of electric heat make it economical in heating rivets, heat-treating of steel, drying and baking armature coils, melting lead or babbitt and for operating soldering iron furnaces, glue pots, core baking ovens, varnish drying ovens, etc.

Most of this development is very recent and it is not surprising that some possibilities have been overlooked.

For example, the internal resistance of a locomotive tire is enough so that a simple electrical device can be used to expand it for the purpose of shrinking it onto the wheel center. Such a device described elsewhere in this issue, consists simply of a transformer without a secondary coil.

A shop-made device operating on this principle has been in use on the Norfolk & Western for several years for expanding motor pinions for electric locomotives and for this purpose has been found highly satisfactory. In so far as operation is concerned, the principle should apply equally well for the heating of tires and the cost is not prohibitive. According to the manufacturers, a 72-in. locomotive tire weighing 1,230 lb. can be expanded sufficiently for shrinking onto the wheel center in 20 minutes with an energy consumption of 12.2 kw. hr. With power costing 1½ cents per kw. hr., the cost of heating the tire would be less than 20 cents. Considering the facts that the heat is perfectly uniform and can be controlled accurately, that the work is quick and clean, and that the oxidizing effect of a flame is dispensed with, the practice is well worth consideration.

New Applications of Welding

The need for repairing damaged ships, locomotives and other machinery was probably the greatest factor in furthering the development of electric arc welding. The urgent need during the war for getting a maximum service out of locomotives, ships and machinery of all kinds was the necessity which mothered many inventions. In such times of stress, practices are resorted to which were previously considered dangerous or impracticable. The result of this is that these practices are frequently developed and made suitable for regular repairs. Some roads are now repairing truck equalizers, axles, wheels and couplers with the electric arc. Such practices are not permitted by the A. R. A. code of rules governing repairs to freight and passenger cars for the interchange of traffic. These rules, however, do not prohibit a railroad from repairing its own cars as it sees fit and roads on which welding has been developed to a high degree have found it practicable and desirable to adopt these practices. The probable outcome will be that when more roads have developed welding to the degree of those now leading the procession, the rules of interchange will be modified.

The impetus given to welding by the need for repairing machinery was naturally reflected in the various manufacturing processes. Electric welding has been used for a long time in manufacturing, but its use has increased tremendously in the last few years. Such machinery as the automatic and semi-automatic welders have greatly aided this development. Tank manufacture has been very much affected by the adoption of electric and gas welding.

The application of welding to structural work has not kept pace with its application to repairs and manufacture. It has been used effectively in the construction of bridges and of buildings, but the applications have been limited to isolated cases. An ingenious application of welding to structural work was made recently in connection with the Mexican Railway electrification now being installed by the General Electric Company. Poles for supporting the overhead contact system were constructed from discarded steel rails. One of these poles is shown in connection with an article appearing elsewhere in this issue. This is a new application of welding to structural work, but it is also more than that—the pole is a by-product of the scrap heap. There are undoubtedly many more such by-products that could be developed which are waiting for the ingenuity of the man in the field or shop to bring them out.

New Books

Atlas of the U. S. A. Electric Power Industry. By Frank G. Baum, consulting hydro electric engineeer, San Francisco, Cal. Bound in cloth, 21 pages of text, 34 plates, 11 in. by 15 in. Published by the McGraw-Hill Book Company, New York. Price $10.

This atlas is divided into two parts. The first part deals with the subject of electric power industry; suggested power districts and proposed potential transmission systems. The second part covers electric power transmission as accomplished by the constant potential systems. A vast amount of valuable material is to be found in the way of charts, diagrams, table and maps. Power transmission systems, both those in operation at present and those proposed, are treated very extensively. The entire United States is included in the information compiled and the author has gone into such detail that practically every important point has been touched upon in the development of electrical energy either by water power or steam.

Locomotive Catechism. By Robert Grimshaw, 958 pages, 5½ in. by 7¾ in., 468 illustrations, bound in cloth. Published by the Norman W. Henly Publishing Company, New York.

This is the thirtieth edition of a book which for a number of years has been considered as the standard authority in its class. It is written in a simple and easily understandable manner such as will appeal to firemen, engineers, trainmen, switchmen, shop hands and enginehouse men for whom it has been prepared. The text follows the form of examination questions and answers, of which there are some four thousand. Considerable new matter has been added in this edition and the old matter carefully revised. This includes a chapter on electric locomotives. There is also a chapter on the electric headlight. The chapters, of which there are eighty-nine, are short and conveniently headed for ready reference and cover the various details, such as boilers, cylinders, valve gear, running gear, superheaters, air brakes, etc. The book tells not only what to do, but also what not to do and is specially helpful for a person preparing for an examination for promotion.

Mining Electrician's Handbook. By Lionel Fokes. Wigan, England, Thomas Wall & Sons, 1923. 414 pp., illus. diags., 8 x 5 in., cloth. 10s. 6d.

The author of this book has had several years' experience in the installation of electrical equipment in the South Wales coal field and in coal mining. His book is intended to provide mine electricians, managers and engineers with a practical treatise on electricity, setting forth simply the fundamental principles that underly the operation of electrical apparatus and giving hints on its maintenance under mining conditions.

Interior of the Norfolk and Western Enginehouse at Shafer's Crossing as It Looks at Night

Roundhouses With Plenty of Light

Norfolk and Western Uses 1,200 Watts Per Stall in Overhead Units With Surprising Results

A NUMBER of unusual features have been incorporated in the wiring and lighting systems installed recently in 10 Norfolk and Western enginehouses. More light is provided than usual, the power consumption varying from 500 to 1,800 watts per stall; all of the lights are controlled from a single switch; indoor, open wire feeders are used; the lighting units are of the fluted type mounted overhead, and a type of unusually rugged and simple extension outlet has been developed and adopted.

Location	Length of Stall	Total No. Fixtures Per Stall	No. of 200 W. Lamps Per Stall	No. of 300 W. Lamps Per Stall	No. of 500 W. Lamps Per Stall	Total Watts Per Stall	Watts Pe Ft. of Stall Length
Lambert's Point	100 Ft.	6	6	0	0	1200	12
Crewe	100 "	5	3	2	0	1200	12
Shenandoah	115 "	6	4	2	0	1400	12.1
West Roanoke	71 "	5	5	0	0	1000	14.1
West Roanoke	100 "	5	3	2	0	1200	12
Shafer's Crossing	115 "	6	4	2	0	1400	12.1
East Radford	47 "	2	1	1	0	500	10.6
East Radford	77 "	3	1	2	0	800	10.4
Bluefield	100 "	3	0	3	0	900	9.0
Williamson	87 "	3	0	3	0	900	10.3
East Portsmouth	87 "	6	6	0	0	1200	13.8
East Portsmouth	115 "	6	6	0	0	1200	10.4
Columbus	100 "	5	3	2	0	1200	12
Columbus	120 "	6	4	2	0	1400	11.6
Shafer's Crossing, Cross Section at Crane Runway	115 "	6	4	0	2	1800	15.7
Shenandoah, Cross Section at Crane Runway	115 "	6	4	0	2	1800	15.7
Maximum	120	6	6	3	2	1800	15.7
Minimum	47	2	0	0	0	500	9.0
Average	97.7	4.9	3.8	2.1	2	1193	12.1

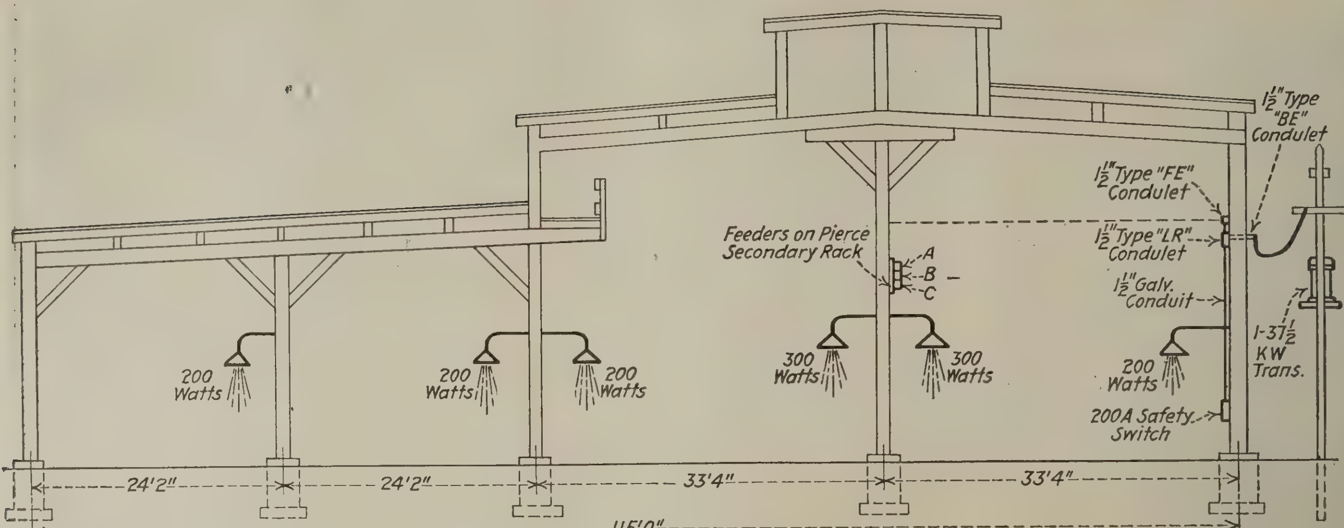
Index and Data for Electrically Lighted Enginehouses

The arrangement and size of units in the various enginehouses vary with the design of the building, but the methods used are simple and easily adapted to the different requirements. In general, the service transformer is mounted on a pole outside the house as near as possible to a point half way round the circle. The transformer usually has a ratio of 2300/220 with the secondary neutral brought out to provide an Edison 220/110 three-wire circuit. The neutral is grounded at the base of the transformer pole and the three secondary wires are carried into the house through rigid metal conduit and condulet fittings, as shown in one of the illustrations, to a switch mounted on the outer circle wall. This switch, which is a safety type externally operated switch in a metal cabinet, is the only switch in the enginehouse and controls all of the lights. From the switch the service wires are carried up the outer circle wall to a point 22 ft. above the floor, where they are brought out of a condulet and carried open toward the center of the enginehouse circle to the first line of columns on which the feeders are carried.

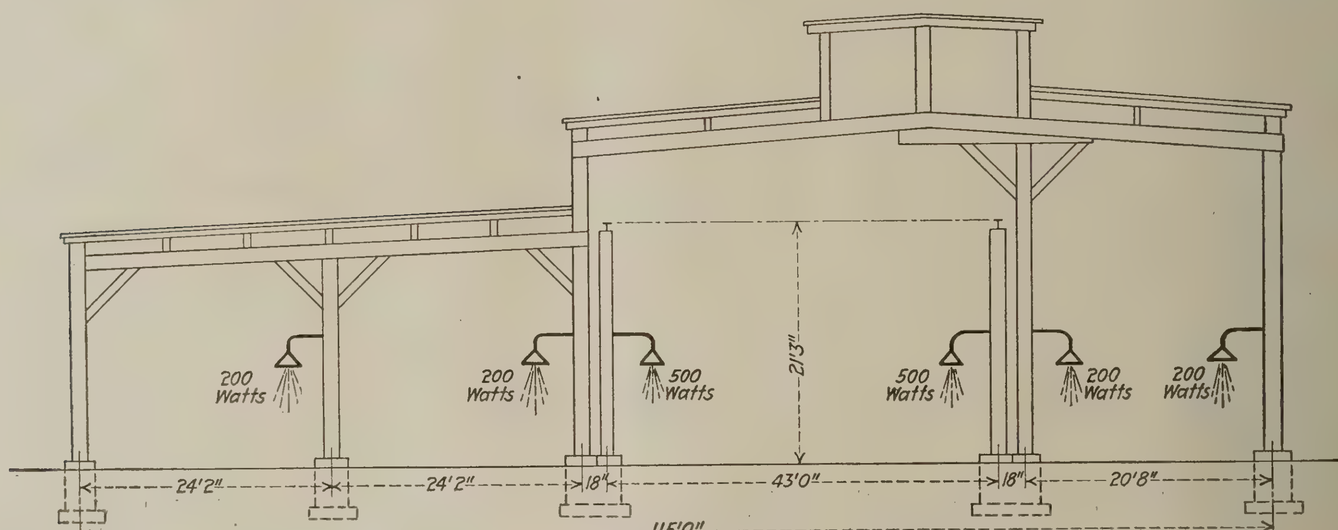
Open wiring is used for the feeders, which are supported on Pierce secondary racks. The racks are usually mounted on the circle of columns nearest to the outer circle wall about 20 ft. above the floor. The wire is triple braid weatherproof wire.

Branch circuits from the feeders to the lighting units and extension outlets are carried from the feeder to the outlet in ½-in. rigid metal conduit fitted with a condulet at either end. The branch circuits are protected by double pole Edison plug cutouts.

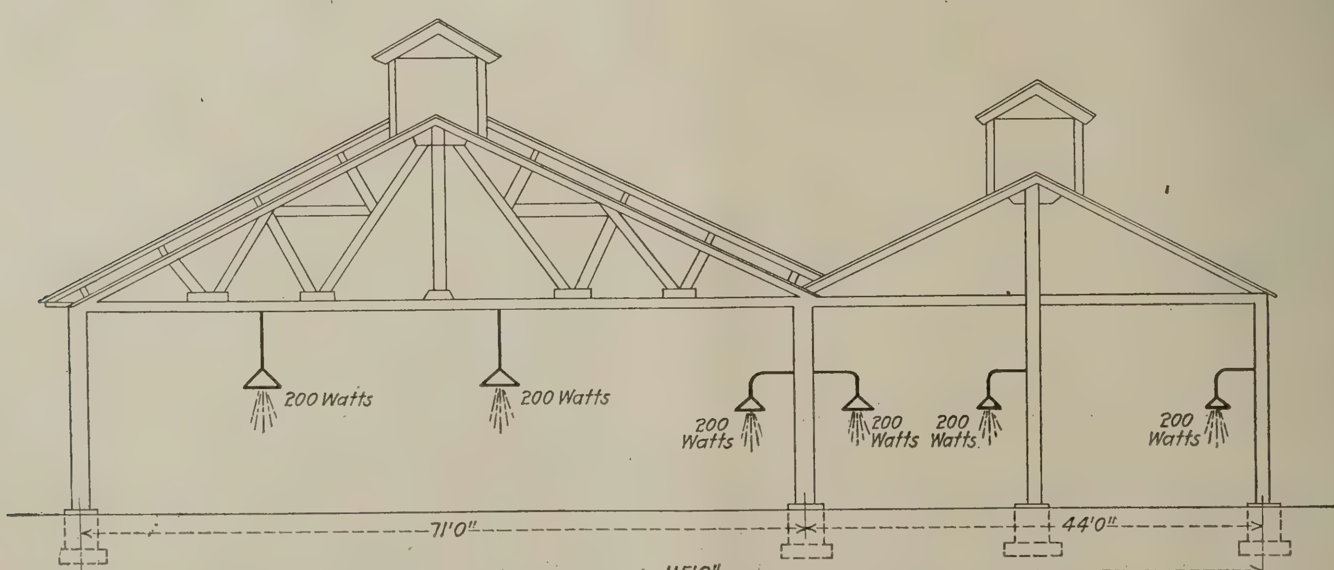
The lighting units are General Electric pressed steel units with dome radially fluted reflectors. The reflecting surface of these units is essentially horizontal and the dome section at the center allows the lamp to be drawn up so close to the fluted surface that the rays from the filament strike it at an acute angle thus reflecting a large



SHENANDOAH, VA. TOTAL NUMBER OF STALLS 13.



SHAFER'S CROSSING, ROANOKE, VA. (CROSS SECTION AT CRANE RUNWAY). TOTAL NUMBER OF STALLS 12.

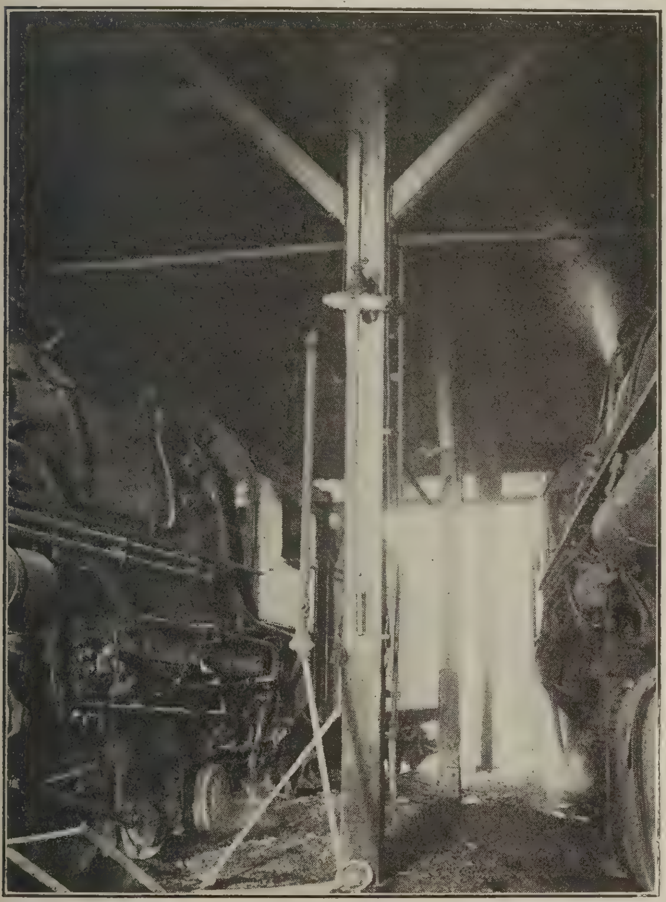


EAST PORTSMOUTH, O. (CROSS SECTION SHOWING EXTENSION). TOTAL NUMBER OF STALLS 24.

Cross Sections of Three Norfolk and Western Enginehouses Showing Typical Arrangements of Lighting Units

amount of the light at the higher angles. They are mounted fifteen feet from the floor on brackets on both sides of each supporting column and on inner or outer circle walls, depending upon the design of the house. In some cases the construction of the house makes it necessary to suspend the lighting units from the roof truss on conduit stems.

Most of the lamps are 200 or 300 watt lamps but 500 watt units are used in enginehouse sections which have a crane span, on account of the increased distance between the location of lighting fixtures. One of the illustrations shows the location of lights for the enginehouse at Shafer's Crossing. The section of the house shown in the drawing includes the crane runway. In the balance of the house in which there is no crane runway, the sup-



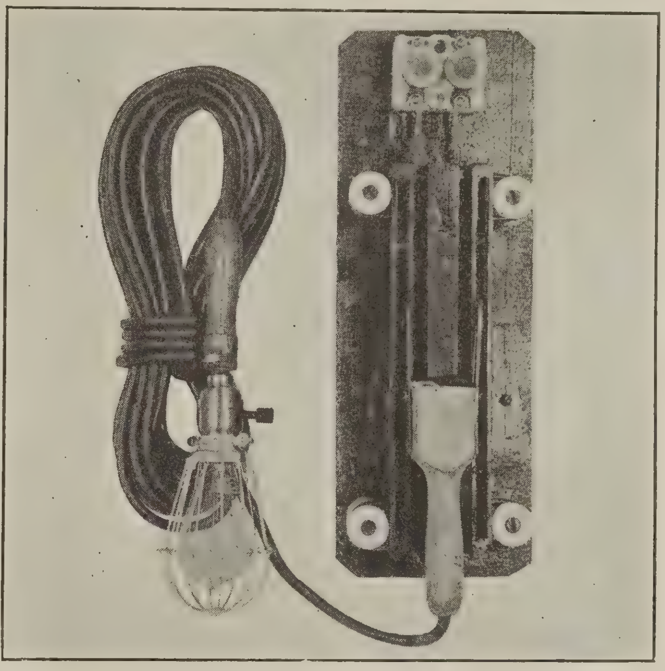
Daylight Interior View of Enginehouse Showing Location of Extension Outlets, Lighting Units and Feeders

porting column nearest to the outer circle wall is placed so that it supports the roof at a point just under the center of the monitor roof. In this part of the house 300-watt lamps are used in place of 500. There are 12 stalls included in the crane section and 28 in the rest of the house.

The portable extension outlet is an unusually simple and rugged affair which is made in the railroad shops. It consists essentially of two special iron castings supported by four U bolts on four solid porcelain knobs, as shown in one of the illustrations. Each casting has two ribs with four inside bosses between them. A wooden baffle is placed between the two castings to prevent accidental short circuit. The four knobs are screwed to a piece of 1-in. board and the cutout is mounted on the same board, thus forming a unit which is assembled in the electrical shop and mounted with screws on the enginehouse columns.

The extension plug on the portable cord in this case consists of a pair of hooks made of flattened No. 0 wire screwed to the opposite sides of a wood handle. When a light is connected it is done by hanging the cord and handle by means of the two hooks from two of the bosses on the outlet castings. Four extensions can be connected to one outlet and there is one outlet per stall mounted on the columns in the enginehouses. The extension lamp is a carbon lamp in a brass socket. The lamp is protected by a wire guard and the socket is mounted on a wooden handle. Portable reinforced cord is used to connect the lamp to the connecting hook.

The system as a whole can be said to be most effective. Seen at night there can be no question in the mind of the observer that there is plenty of light for the men working in the enginehouse. Conservative users of light might



Portable Extension Light and Extension Outlet

think the cost of power for lighting was unwarranted, but such doubts can be dispelled when the facts are known. The power cost at most of the locations is about 1¼ cents per kilowatt hour. At this rate the power for lighting a 30-stall enginehouse costs less than the services of one man. It is the opinion of the operators that the lights increase the efficiency and usefulness of the whole roundhouse force to such an extent that the power cost represents a saving rather than an expense. The lighting is also, undoubtedly, an important factor in preventing accidents.

A Correction

On Page 267 of the *Railway Electrical Engineer* for September in an article entitled "Motor Renders Long Service," the name of the railroad was erroneously given as the Atchison, Topeka & Santa Fe. This should have been the South Pacific.

Electric Welding for Safe-Ending Boiler Tubes

The practice of using an electric butt welding machine for safe-ending locomotive boiler tubes is employed in several Union Pacific shops with results that show the practice to be thoroughly dependable and economical.

The machinery used consists of a Federal electric safe-end welder, an O'Neil roller, an old turret lathe and a shop made device which is a combined cutter, reamer and grinder.

The combined cutter, reamer and grinder is shown in Fig. 1. The first operation is to cut off the ragged end of a tube which has been removed from a boiler and to which a safe end is to be welded. This is done in the cutter shown in the foreground in Fig. 1.

It has been found that tapered or beveled ends are more suitable for obtaining a good weld than ends cut off square and butted together and for this reason the reamer just back of the cutter is included. After the tube is cut off, the end is placed against the revolving reamer. The air cylinder is used to clamp it in the vise or clamp which slides on the two horizontal rods and the vertical lever is used to force the end of the tube against the reamer.

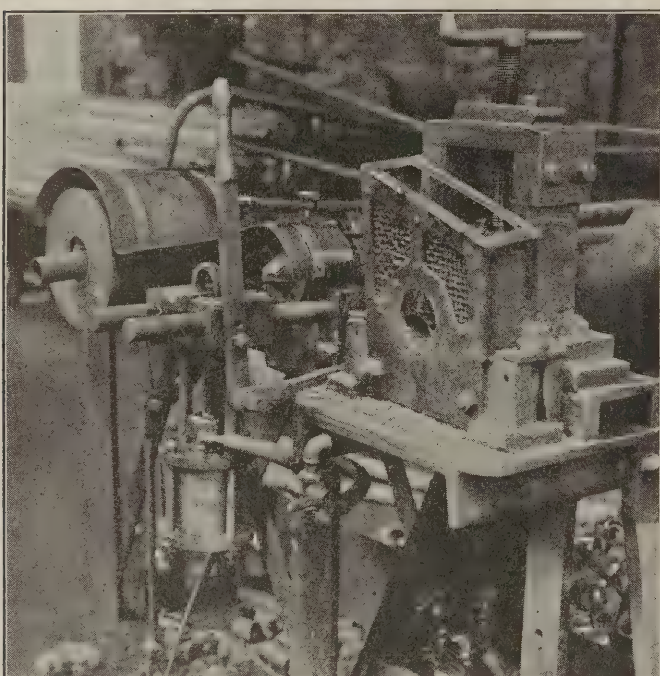


Fig. 1—Pipe Cutter, Reamer and Grinder Used to Prepare Boiler Tubes for Welding On Safe-Ends

The welding is done by the resistance method and the welding electrodes must make good contact with the tube and with the safe end or the tube and safe end will heat where they are held by the electrodes instead of at the junction of the tube and the safe end. To insure this good contact the grinder shown at the rear in Fig. 1 is included. Inside of the rotating head are four blocks of emery which are thrown outward inside the head when the machine is running. The tube is inserted in the hole in the center of the head, the four blocks are pressed toward the center by a foot lever and are held there until the rust and dirt is removed from the outside of the tube at the point it is to be gripped by the electrode of the welding machine. In the illustration a safe end is shown protruding from the grinder. This is inserted simply to prevent the emery grinding blocks from falling out of the center hole when the machine is not in operation.

An old turret lathe has been fitted up for cutting safe ends. A piece of boiler tube which is to be cut up into safe ends is fed through the spindle of the lathe and is cut off by a tool on the cross side so that it has an external taper which will just fit the inside taper in the tube made by the reamer. A tool on the turret is then set forward into the end of the safe end to remove the wire edge produced by the cut-off tool. Another grinder, similar to the one shown in Fig. 1, is used to clean the outer surface of the safe ends. Two safe ends that have been made ready for the welder are shown in Fig. 2.

Fig. 2—Two Safe-Ends Ready for Welding

The welding machine is shown in Fig. 3. The tube and the safe end are clamped in the pneumatically operated, water cooled, copper electrode jaws of the welder and are forced together by the hand lever shown in the foreground. When the two ends are brought together the welding current flows through them between the two electrodes and the contact resistance and current are sufficient to bring the junction to a welding heat in about 45 seconds. A welding speed of 30 seconds is possible. The tube is then removed quickly and placed on the roller which finishes the weld by compressing and shaping it.

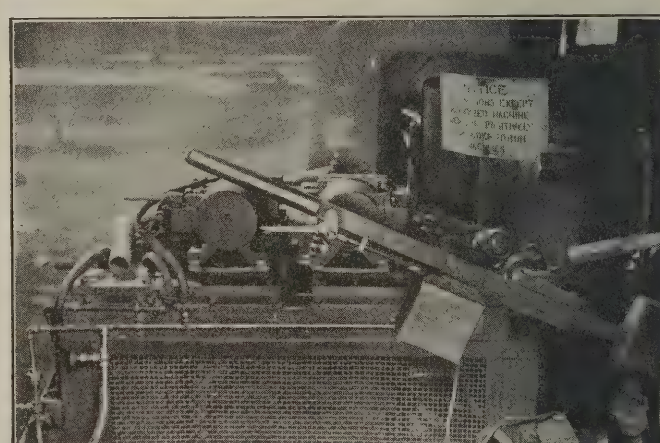


Fig. 3—Federal Electric Safe-End Welder

After the weld is made it is tested on a hydraulic tester. The continuous operation of the plant, including the preparation of the tubes and safe ends, the safe-ending and the testing requires six men. The average capacity of the plant is about 400 flues a day.

Chicago, Rock Island & Pacific has awarded a contract to the Roberts & Schaefer Company, Chicago, for the erection of a 200-ton automatic electric coaling station of frame construction at Hutchinson, Kan.

Enginehouse Lighting on the Great Northern

Method Used is Durable and Not Expensive—32-Volt Extension Circuits are a Feature

A METHOD of wiring enginehouses has been developed on the Great Northern Railway which has the advantages of low first cost, overhead lights and durability. The type of wiring used has now been in service in several houses for eight years and is still in good condition.

The feeders consist of three double braided, rubber covered wires, of a size depending upon the size of the enginehouse and the location of the service, in 1-in. or 1¼-in. galvanized rigid metal conduit. This conduit is run inside the house on the outer circle wall six feet from the floor. The three-wire system is used with 220 volts across two wires and 110 volts of the two wires to the third wire, which is grounded.

A cabinet box is placed in the run of feeder conduit between each pair of stalls, as shown in Fig. 1. These cabinets are made in the G. N. shops and are 9 in. square by 4 in. deep, with sloping bottoms to prevent the use of the cabinet as a place to store odds and ends and to allow the moisture of condensation to drain off. Inside of the cabinet there are two double pole Edison fuse blocks and one double pole snap switch mounted on Transite asbestos board. The switch and one fuse block control and protect a circuit on which there are two overhead lighting units and the other fuse block protects one portable extension circuit. Ten ampere fuses are used for both circuits.

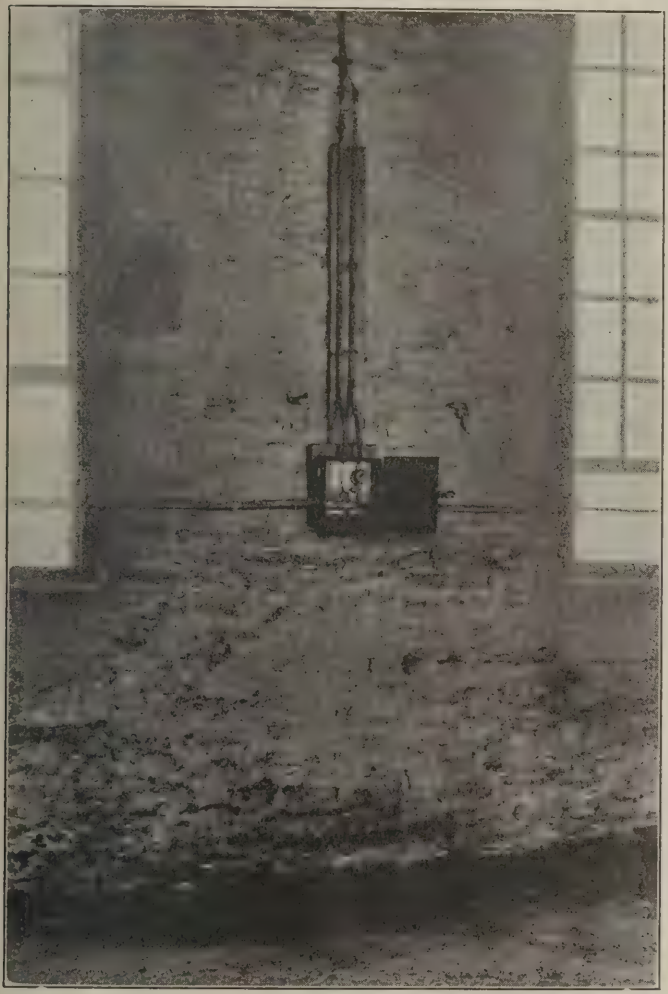


Fig. 1—One Control Cabinet is Placed on the Outer Wall Between Each Two Adjacent Stalls

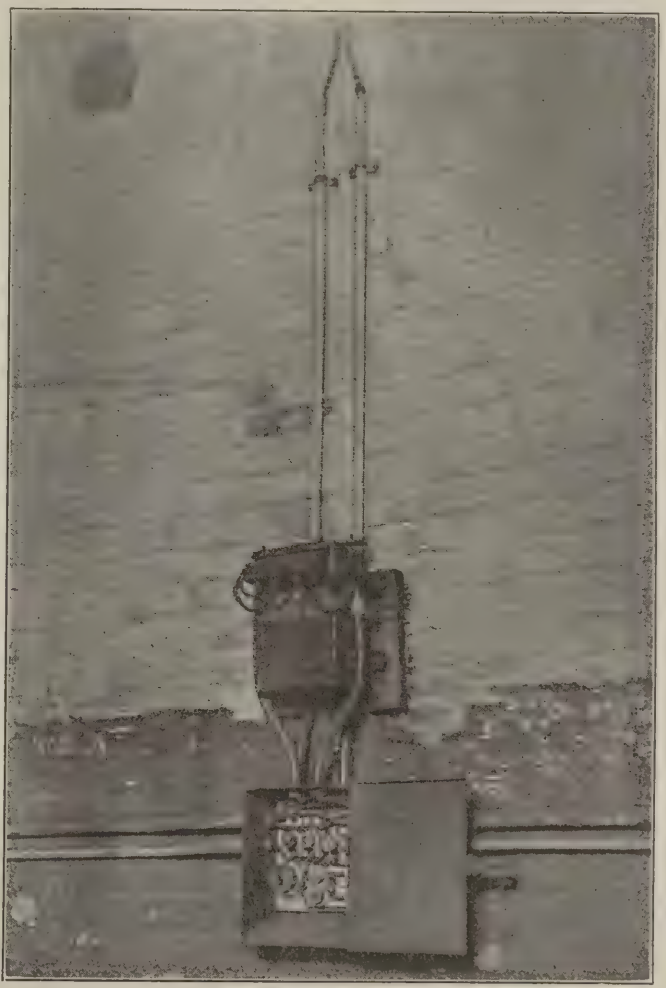


Fig. 2—One 500-Watt Transformer Supplies 32 Volts for all the Extensions in One Section

The lighting units are Benjamin x5425 or x5423 enameled metal reflectors with 220-volt or 100-watt type C lamps. These units are supported from the roof timbers on goosenecks of rigid metal conduit, as shown in Fig. 4. Three galvanized pipe straps nailed to the timber support each gooseneck. There are two lighting units between each pair of stall tracks, and they are staggered in position, i.e., between one pair of stalls there is a light over the outer circle runway and another between the first and second supporting columns, while between the adjacent pair of stalls there is one light between the first and second supporting column and another between the second supporting column and the inner circle wall.

There are two or three extension outlets on the inner post between each pair of stalls, as shown in Fig. 3. These are Hubbel 5624 receptacles in W C and W condulets. The extensions are made of Rome Super Service, Royal Cord or Tirex portable cord fitted at one end with a Hubbel 5700 plug and at the other with a 1451 National lamp guard.

Lead Covered Wire Used Overhead

Probably the most outstanding feature of the installation is the way the branch circuits are run from the cabinets to the lighting units and extension outlets. All of this wiring is run overhead and consists essentially of duplex, lead covered, rubber insulated wire fastened to the wall or roof timbers with lead straps and copper nails. This wire is run up from the cabinet box and from the extension outlets through a ten-foot piece of rigid metal conduit to protect it from physical injury. Where the wire emerges from the top of the conduit, both the wire and conduit are covered with friction tape so that the end of the pipe is sealed. The tape is then painted with P. & B. paint.

Fig. 3—There Is One Group of Two or Three Extension Outlets on the Inner Post Between Each Two Adjacent Stalls

At the point where the wire is brought to the first lighting unit it must be spliced to serve the second unit. Splicing, of course, necessitates the removal of the lead sheath and after the splice is made, it is covered heavily with tape and painted with P. & B. paint.

32-Volt Extensions

In a few of the more recent installations 32-volt circuits are used for the portable extensions. These have been installed to provide greater safety and comfort to the men working on the locomotives, particularly those who must work inside the fireboxes. To provide the 32-volt power one small transformer is placed in each section of the roundhouse, as shown in Fig. 2. The transformers are built in the Great Northern shops, are oil-cooled, have a capacity of 500 watts, and a ratio of 110/32 volts. Each transformer is placed over the cabinet which happens to be nearest to the center of the section and a fuse block is placed in this cabinet to protect the primary coil. The secondary or 32-volt circuit is carried in ½-in. rigid metal conduit, run just below the feeder conduit, to the other cabinets in the same enginehouse section. Fuses in each cabinet protect the branch circuits which run overhead from the cabinets to the extension outlets.

Fig. 4—Each Lighting Unit Is Supported by a Conduit Gooseneck and Three Pipe Straps

The only part of the system which has shown any considerable depreciation are the goosenecks which support the lighting fixtures. Aluminum conduit will be tried for this purpose. The system was developed by E. Marshall, electrical engineer.

Hurdle Race, P. R. R. Athletic Meet, Altoona, Pa., Sept. 22.

Self-Propelled Cars for Branch Line Service

A. E. R. A. Committee on Heavy Electric Traction Extends Activities

AT the annual convention of the American Electric Railway Engineering Association, held in Atlantic City October 8 to 12, the Committee on Heavy Electric Traction presented a report which embodied a number of interesting features with reference to the development of electric operation, particularly in connection with the electrification of branch lines.

Bibliography of Heavy Electric Traction and Electrification Data

There exists at the present time a very extensive bibliography on the subject of heavy electric traction which is being augmented continually. In view of the importance of this bibliography, it was said by the committee that it would be desirable to keep it up to date and in following out this idea, the bibliography has been checked and revised by Professor R. B. Warner, of Yale University. It was suggested that a complete rearrangement of the list be made, classifying together all articles in a given periodical during any one calendar year, assigning to each article a reference number, and from this compiling the subject index which would then consist only of reference numbers as assigned to the preliminary list. The work would thus comprise columns (1) a group of articles in any one periodical, (2) a chronological grouping, and (3) a subject index. Subsequent additions may readily be made as desired without material addition to the cost of printing.

It has also been suggested that the number of periodicals indexed be materially reduced, and only those included which contain consistently articles or papers of value on electrification in reasonable quantity. With a restricted list of periodicals, annual additions can be readily made and completeness insured.

The committee recommended that the suggestions be carried out and that a complete bibliography, rearranged as outlined, be compiled and printed next year and automatically revised from year to year.

Branch Line Electrification, Self-Propelled Cars, and Storage Battery Locomotives for Yard Work

In some instances railroads having terminal electrification have extended such electrification over comparatively short branch lines in advance of extensive main line electrification, thus providing improved facilities for short haul suburban traffic. In other cases branch lines have been electrified by means of overhead trolley or third rail in advance of terminals or main line electrification. In a few instances this has been done even when such electrification was not immediately contemplated. There are also instances where railroads have granted trackage rights to interurban traction companies over branch lines, the traction company installing overhead trolleys and operating an interurban passenger service and a steam railroad continuing to operate freight and through passenger service with steam locomotives.

With few exceptions, branch line electrifications were made several years ago and there has been no material development during recent years. Your committee, therefore, had not made a comprehensive investigation of the situation involving the issuance of questionnaires, etc., feeling that such information would not be of material value, particularly in view of the fact that the recent tendency has been to substitute self-propelled cars for steam service on branch lines where through service is not essential and the maintenance of steam service is burdensome.

The self-propelled car (internal combustion engine, steam engine or storage battery) is undoubtedly of interest to those responsible for electric railroads as well as to the operators of steam road branch lines. The vehicle which can be operated on any track whether it is electrified or not is a valuable transportation facility, and under many circumstances can compete favorably with the electrified system. The operating problems of the steam railroad branch line are often quite analogous to those of the interurban electric road, especially when the traffic demands are relatively light, and the most economical solution in either case may be electrification; or it may be gasoline, storage batteries, or steam self-propelled cars. In at least one instance, electric operation of an interurban line has been abandoned in favor of gasoline rail equipment on account of a sudden falling off of business. Joint operation of various kinds of equipment is not uncommon and often provides a satisfactory solution for both local service and through traffic problems.

In 1912 an extremely comprehensive report was prepared covering the development of self-propelled cars. The cars developed at that time were of various types, such as gasoline, steam, compressed air, storage battery, etc. The most successful types, however, were gasoline cars with either mechanical drive, as in the McKeen car, or electric drive, as in the cars built by the General Electric Company, and light storage battery cars. The then recent development of the Edison cell had provided a stimulus to the use of storage battery cars.

Subsequent to 1912 an interruption seems to have occurred in the development of self-propelled cars for branch line operation and the manufacturer of the two leading gasoline driven types was discontinued. Storage battery cars have continued in operation, but extension of service has been slow in recent years.

Recently, on account of serious financial conditions which have prevailed, and on account of traffic problems brought about by competition from public and private automobiles, renewed interest in the self-propelled car has been manifested. A number of roads in this country and abroad have adopted and are operating successfully a type of gasoline-driven car considerably smaller than those which were most common in 1912. The development of the gasoline engine and mechanical transmission for automobile trucks has undoubtedly been largely responsible for this recent rapid growth of light, self-propelled, car operation. Many characteristics of these cars are identical with motor truck standards.

Although in this country and Canada the railroads

Table I

Self Propelled Cars for Branch Lines or Auxiliary Service

Company No.	Name of railroad	Track equipped with signal circuit	Number in service	Date placed in service	Manufacturer	Weights—(Lbs.) Total	Driver and other trucks	Single or double end	Number in crew	Seating capacity	Speed—M. P. H. Max.	Av.	Average distance between stops (miles)	Max. grade (percent)
1	Atlantic City R. R. (R. & R. System)	No	1	Mar. 9, 1923	J. G. Brill	29,760	17,820-11,940	Single	3	40	40	35	1.5	0.77 & 0.49
2	Atchison, Topeka & Santa Fe	Partially	2	1913	G. E. Co.	125,290	76,890-48,400	Single	3	90	50	26.8	4.73	68.6
		No	1	June 3, 1917	Hall-Scott Motor Car Co.	67,120	......	Single	3	50	......	26	6.5	31.7
3	Atlantic & Western R. R.	No	3	Oct., 1906	Edwards Ry. Motor Car Co.	17,000	60% on drivers	Single	2	50	35	25	3.0	3.8
4	Baltimore & Ohio	......	1	Oct., 1922	Edwards Motor Car Co., Sanford, N. C.	17,220	7,640-9,580	Single	2	22	30	15	4.5	2.0
5	Cambria & Indiana R. R. Co.	No	1	Oct., 1022	Service Motor Truck Co.	29,880	......	Single	2	40	37	20	3.0	4.5
6	Carolina, Clinchfield & Ohio Ry.	No	1	1916	G. E. Co.	100,000	......	Single	3	88	45	30	4.0	1.2
7	Central New York Southern R. R. Co.	No	2	1914	McKeen Motor Co.	74,000	......	Single	3	83	60	40	6.0	1.5
8	Chicago Great Western	Yes	1	Feb., 1923	Service Motor Truck Co.	28,000	......	Single	3	46	45	35	8 to 10	1.0
		Yes	1	Feb., 1923	Sykes Co., Kenosha, Wis.	......	......	Single	3	36	45	35	8 to 10	1.0
		Yes	3	1912	McKeen Motor Co., Omaha, Neb.	69,800	43,200-26,600	Entrance in center of car	3	80	50	35	8 to 10	1.0
9	Chicago, Rock Island & Pacific Ry. Co.	No	0	4 were placed in service, 1910	McKeen Motor Car Co.	68,000	24900 on drivers	Single	3	84	32.5	30	6.75	0.01
10	Cowlitz, Chehalis & Cascade Ry.	No	2	Mar., 1916 Feb., 1923	First car made in our shop; other by Hickey Motor Co.	12,000 21,000	....	1 single 1 double	1 2	29 67	45 35	25	4.57	1.8 ......
11	Fonda, Johnstown & Gloversville R. R. Co.	No	2	Aug. 15, 1922	Service Motor Truck Co.	28,000	......	Single	2	46	45	35	1.3	0.02
12	Fort Smith, Subiaco & Rock Island R. R. Co.	No	1	Just rec'd	Service Motors, Inc., Wabash, Ind.	......	......	......		28-40	......	......	......	3.75
13	Fresno Interurban Railway Co.	No	1	1916	Hall Scott Motor Co., Calif.	65,000	......	Double	3	......	35	10	1.0	1.0
14	Gilmore & Pittsburgh	No	1	......	Mack Motor Car Co.	12,270	......	Single	1	17	20	18	10	1.0
15	Great Northern	......	1	......	International Motor Car Co.	19,675	......	Single	2	36	......	......	......	......
		......	1	......	Four Wheel Drive Auto Co.	17,000	......	Single	2	......	......	......	......	......
		......	1	......	White Motor Co.	......	......	Single	2	36	......	......	......	......
		......	1	......	Service Motor Truck Co.	26,000	......	Single	2	38	......	......	......	......
16	Holton Interurban R. R.	No	1	1912	Hall Scott Motor Co.	......	......	Double	2-4	......	40	20	......	1.0
17	Jonesboro, Lake City & Eastern R. R.	Yes	1	Sept. 1, 1922	The White Co. and Southland Motor Body Corp.	12,000	......	......	1	46	40	12.5	5	......
18	Nevada Copper Belt R. R. Co.	No	2	1910, 1913	Hall-Scott Motor Car Co.	70,000 80,000	......	Single	2	48	40	35	12	3.25
19	Middletown & Unionville R. R. Co.	No	2	Mar., 1921 Nov., 1922	Reo Motor Car Co., Gramm Bernstein Motor Co.	9,750	......	Single	2	18 & 30	45	25	4	1.86
20	New Orleans Great Northern R. R. Co.	No	1	Feb. 11, 1923	Service Motors, Inc., Wabash, Ind.	28,000	......	Single	3	33	40	30	2.8	0.003
21	New York, New Haven & Hartford R. R.	Yes	3	Jan., 1922	International Motor Co., Osgood Bradley Co.	23,700	13,900-9,800	Single	2	35	45	22.4 21.6 23.0	5.0 2.6 2.6	.8 1.6 1.9
22	Northern Pacific Ry. Co.	No	1	Sept. 12, 1922	Mack International Motor Co.	20,670	11,790-8,880	Single	2	35	35	28	4.3	1.2
23	Norwalk & Shelby R. R. Co.	No	2	Jan. 1, 1923	American Ry. Motor Car Co., Elyria, O.	28,000	......	Single	2	42	35	25-30	1.5	6.0
24	Oklahoma Southwestern Ry.	No	1	Oct., 1922	Four Wheel Drive Auto Co.	17,500	Equally between two 2-wheel trucks	Single	2	16	30	12	2.5	.07
25	Penn. R. R. System	Yes	3	Feb., 1923	J. G. Brill-Service Motor Truck Co.	30,000	18,000-12,000	Single	2	44	45	37.5	......	3.0
26	Quebec, Montreal & Southern Ry. Co.	No	3	Sept., 1922 April, 1923	Ledoux Jennings, Limited, Montreal, Canada.	19,000	Equally between other trucks.	Single	2	34-36	40	25-30	5.0	.9
27	Quincy R. R. Co	No	1	Mar., 1918	Meister & Sons Co., Sacramento, Calif.	14,000	......	Single	2	24	20	15	5.0	4.0
28	St. Louis & San Francisco Ry.	No	1	1922	G. E. Co.	110,000	74,000-36,000	Double	4	80	50	26	3.3	1.4
		No	1	1923	G. E. Co.	110,000	74,000-36,000	Double	4	107	50	26	5.8	1.0
		No	1	1922	G. E. Co.	110,000	74,000-36,000	Double	4	90	50	26.5	6.6	1.25
		No	1	1923	G. E. Co.	110,000	74,000-36,000	Double	4	90	50	20	2.5	0.05
		No	1	1922	G. E. Co.	110,000	74,000-36,000	Double	3	80	50	23	4.2	1.0
		No	1	1922	G. E. Co.	110,000	74,000-36,000	Double	3	80	50	25	3.0	0.8
		......	1	1922	Midwest	28,000	74,000-36,000	Double	3	36	45	26	4.5	1.63 1.53
29	Southern Pacific Co.	Yes	19	1909-10-11	McKeen Motor Co., Omaha, Neb.	78,560	49,900-28,660	Single	4	62	33	24	2.8	2.2
30	Stone Harbor R. R. Co.	......	2	May, 1921	Brill Co., Mack Power Plants.	12,000	......	Single	1	32	28	20	4	3.0
31	Tennessee, Kentucky & Northern R. R.	No	1	July, 1919	White Truck, St. Benard Body.	......	......	Single	1	20	25	20	4	3.6
32	Union Pacific R. R.	No	21	1908	McKeen Motor Car Co.	70,000	25,000-45,000	Single	3	72	50	35	5	2.0
33	Union Transportation Co.	Yes	1	May, 1922	J. G. Brill Co.	21,000	Half and half.	Single	2	42	32	30	3	1.5
34	Valley & Siletz R. R. Co.	No	1	Jan., 1922	Hall-Scott Motor Car Co.	74,000	......	Single	2	46	45	25	4	3.0
35	Yreka R. R. Co.	No	1	June, 1908	Hall-Scott Motor Car Co.	36,000	......	Single	2	24	20	20	8	2.3

Table I (Continued)

Self Propelled Cars for Branch Lines or Auxiliary Service

Company No.	Mileage: Per day	Mileage: Per year	Length of run (miles)	Average number of round trips per day	Trailer capacity, tons	Engine: Rated h.p. (S. A. E. rating for gas engines)	Engine: Method of starting. Air or electric	Lighting system. Electric, gas or oil	Capacity of battery	Is same battery used for starting	Driving wheels: No.	Driving wheels: Are all solidly connected	Driving wheels: If not, describe drive	Type of clutch	Type of transmission
1	140±	40,656	13.6 & 12.5	4.5	0	36.1	Electric	Electric	160 amp. hrs., 12 volts.	Yes	4	No	Solid axle, bevel gear drive, wheels keyed on.	Brown-Lipe multiple disc.	Brown-Lipe
2	148	64,455	74	1	0	175	Air	Electric	......	......	4	No	2 elec. motors, one geared to each driving axle.	......	Elec., from gen. to motors.
	39	12,000	6.5	3	......	100	Electric	Electric	12 v.	Yes	2	No	Pinion gear	Friction	Sliding gear
3	100	36,500	25	2	30	71	Electric	Electric	......	No	4	Yes	......	Dry plate	......
4	160	......	58	......	34	32.5	Electric	Electric	120 amp. hrs.	No	4	Yes	......	Single dry plate.	Drive shaft to jack shaft, chained to rear wheel.
5	100	34,420	15 & 20	3	0	37.5	Electric	Electric	2-120 amp. ea. 6 v. in series.	Yes	4	No	Bevel type	Dry disc	Unit type and bolster sliding selective.
6	86	28,000	43 one way	1	0	200.0	Air	Electric	......	......	4	No	Motors on truck geared to axles.	......	......
7	120	......	30	2	0	200.0	Air	Acetylene gas	Small, for starting only.	Yes	2	Yes	......	Disc, air operated	Herringbone gears
8	282	......	141	1	0	41-68	Electric	Electric	160 amp. hrs.	Yes	4	Yes	......	Multiple disc	Mounted with engine.
	264	......	132	1	38	80	Electric	Electric	120 amp. hrs.	No	4	Yes	......	Disc	Standard auto.
	150	......	75	1	......	200	Air	Gasoline	......	......	2	Yes	......	Special disc type	......
9	130	14,931	130	1	......	200	Air	Gas (original), electric (now)	80 amp. hrs.	No	2	No	......	McKeen Octaroon & friction.	McKeen gear and chain.
10	160	58,400	20	4	......	60	......	Electric	12 v.	Yes	2	No	Connected to rear axle.	Single plate	Sliding gear
11	272	57,707	10-16 & 26	10	0	68	Electric	Electric	500 w.	Yes	4	No	Fixed hub and beveled gears type drive.	Brown-Lipe friction disc.	Brown-Lipe selective gear.
12	136	......	......	......	......	......	......	......	......	......	......	......	......	......	......
13	28	10,220	......	1	......	250	Air	Electric	......	......	4	Yes	......	Drum	......
14	120	37,440	74	1	0	......	Electric	Electric	12 volts	Yes	2	Rear axle full floating	Dual	Multiple disc	A-B Mack
15	......	......	......	......	0	40	Electric	Electric	......	No	2	......	......	Single dry disc	......
	......	......	......	......	40	42	Electric	Electric	......	......	4	......	......	Mult. disc in oil.	Colta 3-speed
	......	......	......	......	0	......	Electric	......	......	......	2	Yes	......	Single plate in oil	......
	......	......	......	......	0	41.8-68	Electric	Electric	160 amp. hrs.	......	4	......	......	Mult. dry disc	3 speed, heavy duty.
16	25	8,000	......	2	......	160	Hand lever on face of fly wheel using pres. gas for combustion.	Electric	6-8 v.	No	2	Yes	......	Contracting band	Select. sliding.
17	125	1,500	30½	4	0	60	Electric	Electric	12 v.	Yes	2	Yes	......	Drum	Gears
18	34-132	35,000	14-24	3	......	150	Electric	Electric	180 amp. hrs.	Yes	2	Yes	......	Band & pulley	Hall-Scott
19	114	36,870	14.6	4	......	27.2	Electric	Electric	160 amp. hrs.	Yes	2	Yes	......	Disc	Gears
20	192	70,080	96	2	0	68	Electric	Electric	......	Yes	4	Yes	......	Mul. Brown disc	Selective
21	59.9	18,750	15.0	2	0	40	Electric	Electric	150 amp. hrs.	Yes	2	......	......	Multiple disc	Gears
	138.7	43,410	68.4	1											
	138.8	43,440	69.4	1											
22	122	44,530	122	1	0	40	Electric	Electric	150 amp. hrs.	Yes	2	No	Propeller shaft connected to axle by bevel gear; no differential.	Single plate disc.	Selective
23	210	152,000	32	8	0	36	Electric	Electric	150 amp. hrs.	Yes	4	Yes	......	Dry plates	Selective
24	122	44,500	122	......	36	60	Electric	Electric	12 volts	Yes	4	No	Pinion and ring gear, full floating axle.	Merchant & Evans multiple disc.	Cotter
25	108	......	......	......	0	......	Electric	Electric	150 amp. hrs.	Yes	4	Yes	......	Dry plate	3-speed gear
26	200	......	100 ea. way	1	0	50	Electric	Electric	90 amp. hrs.	Yes	4	Yes	......	Mult. dry disc.	Standard Reo 3-speed.
27	25	7,500	6	2	......	60	Electric	Electric	......	Yes	Shaft driven	......	......	Friction	Geared
28	210	77,000	105	1	0	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	220	80,000	110	1	......	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	220	73,000	100	1	......	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	108	40,000	54	1	......	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	131	47,000	65.5	1	0	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	155	50,000	77.5	1	......	175	Air	Electric	......	......	4	No	Elec. motor, gear drive.	......	Elec. motor
	200	63,000	100	1	0	60	Electric	Electric	160 amp. hrs.	Yes	4	Yes	......	Bendix	......
29	1,198	437,609	3.8-171	24	0	200	Air	Acetylene gas	......	......	2	......	From transmission to driving axle by chain.	Air operated	Gear and chain
30	30-50	12,000	4.5	10	24	98	Electric	Electric	120 amp. hrs.	Yes	4	......	Geared transm.	......	......
31	76	30,000	19	2	15	35	Electric	Electric	......	Yes	2	Yes	......	Standard White selective.	......
32	160	670,000	32-138	1	......	200	Air	Gas and electric.	240 amp. hrs.	No	2	......	Morse chain	Castiron plate	Two-speed
33	150	54,700	25	3	0	30.	Electric	Electric	160 amp. hrs.	Yes	2	No	Split axle; differential locked.	Multiple disc	Sliding gear, selective.
34	80	29,200	40	1	......	150	Electric	Electric	......	Yes	2	Yes	......	Split steel band	Axle susp.
35	24	8,200	16	1.5	0	94	Hand crank	Oil-electric	12 v.	Yes	2	......	Drives from rear axle.	Band	Planetary

Table I (Continued)

Self Propelled Cars for Branch Lines or Auxiliary Service

Company No.	Number of speeds: Forward	Number of speeds: Reverse	Character of gear shift	Type of brake	Source of pressure for power brakes: Main eng. exhaust, separate compressor or compressor connected to main engine	Brake cylinder or diaphragm brake	Do climatic conditions present problems	Method of heating in winter	Is car heated when in storage	Is difficulty experienced in starting in cold weather
1	6	6	Full selective...	Westinghouse semi-autom.	Compressor connected to main engine by propeller shaft controlled by governor.	Cylinder.......	....	Hot air furnace...	Yes...........	No
2	All speeds, zero to max., forward and reverse.		....	Air...........	Compressor connected to main engine.	Cylinder.......	No...........	Heater..........	Part of time....	No
	4	4	Forward by spg., reverse by air.	....	Compressor connected to main engine.	Cylinder.......	No...........	Heater..........	Yes...........	No
3	4	4	....	Air...........	Separate compressor..........	Brake cylinder..	No...........	Hot Air Furnace..	No...........	No
4	3	3	Selective.......	Air...........	Separate compressor connected to rear axle.	Brake cylinder..	Yes, heavy snow	P. C. Smith hot air heaters.	No...........	Sometimes
5	6	3	Sliding.........	Westinghouse...	Separate compressor connected to main engine.	Brake cylinder..	To some extent.	Hot water circulating.	Yes...........	Yes, in extreme weather allow 20 min.
6	Variable speed motor.	Variable speed motor.	....	Westinghouse...	Compressor connected to main engine.	Brake cylinder..	No...........	Hot water heater..	No...........	No
7	2	1	....	Air...........	Separate compressor connected to main engine (dulpicate source).	Cylinder.......	Useless in snow..	Hot water.......	No...........	No
8	3	1	Standard auto..	Air...........	Compressor connected to main engine.	Brake cylinder..	Yes; some in cold weather.	Hot water.......	Yes; stored in roundhouse.	No
	4	1	Standard auto..	Air...........	Compressor connected to main engine.	Brake cylinder..	Yes; severe cold and snow.	Hot water.......	Yes; stored in roundhouse.	No
	2	1	Air shift........	Air...........	Compressor connected to main engine.	Brake cylinder..	Yes...........	Exhaust from eng..	Yes; stored in roundhouse.	Sometimes.
9	3	3	Comb. air and mech.	Air...........	Compressor connected to main engine, also small auxiliary compressor (gasoline).	Cylinder.......	Yes...........	Hot water.......	Yes...........	Some
10	3	1	Selective.......	Air...........	Main engine exhaust..........	Diaphragm brake	No...........	Exhaust.........	No...........	No
11	6	3	Selective type...	Semi-automatic.	Separate compressor connected to main engine.	Cylinder.......	Some..........	Hot water.......	Yes...........	No
12	....	....	....	....	....	....	....	....	....	.....
13	3	3	Air...........	....	Separate compressor connected to main engine tank.	Diaphragm.....	No...........	....	....	No
14	4	4	Selective.......	Hand..........	....	....	Snow..........	Exhaust.........	Yes...........	No
15	4	4	....	Air...........	....	Brake cylinder..	....	Exhaust.........	....	
	3	1	....	Air...........	....	Brake cylinder..	....	Exh., coal heater..	....	
	3	1	....	Hand..........	....	....	....	Exhaust..	....	
	3	1	....	Westinghouse...	....	Brake cylinder..	....	Coal heater......	....	
16	4	4	Select. sliding...	Air...........	Compressor connected to main engine.	Cylinder.......	No...........	....	No...........	No
17	3	1	Standard auto..	Automatic......	....	....	No...........	Exhaust.........	No...........	No
18	4	4	Selective.......	Automatic......	Compressor connected to main engine.	Brake cylinder..	No...........	Water..........	Yes...........	No
19	4	1	Selective.......	....	Hand operated..............	....	No...........	Exhaust.........	No...........	No
20	6	6	Selective.......	Air and hand...	Compressor connected to main engine.	Cylinder.......	No...........	Hot water.......	No...........	No
21	4	4	Selective.......	Air...........	Separate compressor connected to main engine.	Brake cylinder..	Heavy snows block cars.	Exhaust.........	Yes...........	No
22	4	4	Selective.......	Air and hand...	Compressor connected to main engine.	Cylinder.......	Extreme cold and snow.	Exhaust & stove..	Yes...........	No
23	3	1	Lever....	Air...........	Separate compressor connected to main engine.	Cylinder.......	No...........	Heaters.........	Yes...........	No
24	3	3	Clutch gears continually in mesh.	Band friction...	Main engine exhaust..........	Diaphragm.....	No...........	Exhaut & heater..	Yes...........	Yes
25	4	3	Standard lever..	Air...........	Separate compressor connected to main engine.	Cylinder.......	To some extent..	Hot air heater....	Yes...........	Yes
26	3	3	Standard "H" type.	Hand..........	Main engine exhaust..........	....	Yes; winter.....	Exhaust.........	Yes...........	No
27	2	1	Clutch.........	Brakeshoes.....	Hand....................	....	Yes...........	Exhaust from eng.	No...........	Yes
28	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder..	No...........	Hot water heater..	Yes...........	No
	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder.	No...........	Hot water heater..	Yes...........	No
	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder..	No...........	Hot water heater..	Yes...........	No
	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder..	No...........	Hot water heater..	Yes...........	No
	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder..	....	Hot water heater..	Yes...........	No
	Unlimited to 50 M. P. H.	Unlimited to 50 M. P. H.	....	Air...........	Compressor connected to main engine, also separate auxiliary compressor.	Brake cylinder..	....	Hot water heater..	Yes...........	No
	6	3	Standard.......	Air...........	Main engine exhaust, separate compressor connected to main engine.	Brake cylinder..	No...........	Coal, hot air......	No...........	No
29	2	1	Clutch.........	Air...........	Compressor connected to main engine.	Cylinder.......	No...........	Hot water.......	No...........	No
30	4	1	Hand, separate handle for reverse.	Air and band...	Separate compressor, motor driven.	....	No...........	Exhaust.........	No...........	No
31	4	1	Selective.......	Manual........	....	....	No...........	Exhaust.........	No...........	No
32	2	2	Sliding.........	Air...........	Separate compressor connected to main engine.	Brake cylinder..	Yes...........	Hot water & stove.	Yes...........	No
33	4	1	....	Hand and foot..	Hand and foot..............	....	No...........	Hot water.......	No...........	No
34	4	4	Selective.......	W., E. & M. Co.	Compressor connected to main engine.	Cylinder.......	No...........	Hot water.......	In coldest weather only.	Not often
35	4	4	....	W., E. & M. Co.	Compressor connected to main engine.	Brake cylinder..	Yes...........	Wood stove......	No...........	Yes

Table II

Storage Battery Passenger Cars for Branch Lines or Auxiliary Service

Company No.	Name of railroad	Track equipped with signal circuits?	Number in service	Date placed in service	Manufacturer	Weights (Lbs.) Total	Weights (Lbs.) Drivers and other trucks	Single or double end	Length: Wheel base	Length: Car over all	Number in crew	Seating capacity	Speed (M. P. H.) Maximum	Speed (M. P. H.) Average	Average distance between stops (miles)
1	Canadian National Railways....	No....	2	May; 1921 Feb., 1923	Railway Storage Battery Car Co.	67,000 55,000	All on drivers ..	Double....	5′–6″ 4′–6″	55′–0″ 36′–6″	2	50 30	48 36	21.5 22.2	4.5 3.0
2	Chattahoochee Valley Ry. Co...	No.....	2	....	J. G. Brill Co........	29,700	....	Single.....	13′–0″	32′–0″	2	30	20	15	.25
3	Lewisburg, Milton & Watsontown Pass. Ry.	No....	1	....	J. G. Brill Co........	32,200	50% on drivers.	Double....	....	....	2	36	30	....	....
4	Long Island R. R. Co...........	Yes....	2	1916	The Railway Storage Battery Car Co. & J. G. Brill Co.	28,000	All on drivers ..	Single.....	12′–0″	32′–9″	2	36	33	20	.67
		Yes....	1	1911	Federal Storage Battery Co.	15,000	All on drivers ..	Single.....	8′–0″	26′–6″	2	26	30	18	.6

Company No.	Mileage Per day	Mileage Per year	Length of run: Passenger, freight, mixed (miles)	Average number of round trips per day	Battery: Type	Battery: Manufacturer	Battery: Number of cells	Battery: Voltage	Battery: Are end cells used?	Battery: Is battery removed for charging?	Battery: Type of charging facilities	Battery: Are charging facilities located at one or more places?	Battery: Number of charges per day	Battery: Aggregate length of time battery is on charge per day	Battery: Aggregate length of time battery is discharging per day	Battery: Is charging power purchased or produced?	Battery: Does the regular team crew take care of charging?	Battery: Capacity of battery in ampere hours
1	128.6 108.0	40,252 33,804	64.3 Passenger.	1 1	Edison Storage and Exide.	Edison Storage Battery Co. and Electric Storage Battery Co.	250 110	300 220	No.....	No.....	Motor, generating set.	Each end of run.	2 1	7 hours.... 6 hours.	6 hours.... 5 hours.	Purchased.	No......	450 540
2	96	....	9 and 7 passenger.	6	Edison......	Edison Storage Battery Co.	150 208	250 350	Yes.....	No.....	Edison....	One......	3	4½ hours...	8½ hours...	Purchased.	Yes.......	90 60
3	68	24,820	11 passenger.	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....
4	190	66,180	7.3 passenger.	11	G–6–X......	Edison Storage Battery Co.	236	283	No.....	No.....	Resistance grids.	On car.....	12	12 hours...	9½ hours...	Produced..	Yes, part time.	150
	32.2	9,900	1.1 passenger.	7	A–6.........	Edison Storage Battery Co.	130	156	No.....	No.....	Resistance grids.	One.......	3	2⅜ hours...	2½ hours...	Produced..	Yes.......	300

Company No.	Motors: Number	Motors: Manufacturer	Motors: H. P. One hour rating Natural vent	Motors: Voltage	Number of driving wheels	Are cars equipped for M. U. operation?	Method of heating in winter	Is car heated while in storage?	Lighting system Electricity, gas, oil	Is propulsion battery used for lighting?	If propulsion battery is not used for lighting, give capacity of lighting battery: Ampere hours	Voltage	Number of cells	Brakes: Type	Brakes: Source of pressure for brake power	Brakes: Brake cylinder or diaphragm brakes	Do climatic changes present problems?
1	4 4	G. E. W. E. & M.	25 17½	250 176	8 8	No.....	Hot air ...	Yes.....	Electric.	6 cells cut out for lighting.	....	....	....	Air and automatic air.	Electric air compressor.	Cylinder....	No.
2	2	W. E. & M.	150	160 250	4	....	Hot air and stove.	Yes.....	Electric.	....	90	15	8	W. E. & M.	....	Brake cylinder.	Yes, to some extent.
3	....	....	....	....	4	....	Hot water.	....	Electric.	Yes.......	....	....	....	Air.......	Electric compressor.	Cylinder....	No
4	2	W. E. & M.	20	250	4	Yes.....	Coal heater	Yes.....	Electric.	No.......	150	6	5	Air.......	Compressor..	Brake cylinder.	They do, but overcome by placing batteries in compartments.
	2	G. E. Co..	10	120	4	No.....	Hot water.	Yes.....	Electric.	No.......	300	6	5	Hand.....	....	....	No, as the hot water system keeps the batteries warm.

which have adopted internal combustion cars have conservatively adhered to light vehicles with four-cycle gasoline engines, the normal weight being fifteen tons, nevertheless in Europe the Diesel engine with electric drive is being developed in capacities up to 250 hp. and weighs up to between 70 and 80 tons.

Questionnaires have been compiled and issued to companies operating self-propelled cars, in an effort to collect data of interest. Information has been received from about 30 companies operating internal combustion cars, 3 operating storage battery cars, and 2 operating electrified branch lines. The information is necessarily somewhat incomplete, as some of the companies which operate cars of the type under discussion have not replied to the questionnaire.

The accompanying tables (Tables I and II) show information of interest regarding the operation of the various types of equipment.

Table II (Continued)

Electric Cars for Branch Lines or Auxiliary Service

Company No.	Name of railroad	Track equipped with signal circuit?	Type of car	Number in service	Date placed in service	Character of service: Passenger, freight, mixed	Manufacturer	Weights (Lbs.): Total	Weights (Lbs.): Drivers and other trucks	Single or double end	Number in crew	Seating capacity
1	Erie R. R. Co.	No	Two four-wheel trucks; four motors per car.	8	1907	Passenger		6—96,500 1—116,900 1—117,100	Equally divided	Double	2	36 56 70
2	N. Y., N. H. & H. R. R.	Yes	* Coach † Coach and open ‡ Coach § Coach	25 7 11 1	1895 1895 1907 1908	Passenger Passenger Passenger Passenger	G. E. and W. E. & M. Co. G. E. and W. E. & M. Co. G. E. and W. E. & M. Co. G. E. and W. E. & M. Co.	91,460 64,200 57,600 51,100	All on drivers for closed cars; 50% on drivers for open cars.	Double	2 to 4	57 68 39 32
3	Southern Pacific Co.	Yes		79 motors, 60 trailers.	14 in 1913, balance 1911.	Passenger		M.—114,000 T.— 63,000		Double	2 to 4	116

Company No.	Speeds (M. P. H.): Maximum	Speeds: Average	Average distance between stops (miles)	Maximum grade	Trailer capacity	Motors: Number	Motors: H. P.—One hour rating: Forced	Motors: H. P.—One hour rating: Natural	Motors: Voltage	Are cars equipped for M. U. operation?	Method of heating in winter	Lighting system: Electric, from traction power	Lighting system: Electric, from axle generator and storage battery	Brakes: Type: Passenger	Brakes: Type: Freight	Brakes: Source of pressure for brake power	Brakes: Brake-cylinder or diaphragm brake
1	55	35–40	2	.5%	Two standard coaches.	4	125	100	440	Yes	Electric	Yes	No	Air and hand.		Motor-driven compressor.	Brake cylinder
2	45	23 17 24 20	1.0 .5 1.9 .9	1.1% 1.2 .9 1.2	Three to six coaches.	4 4-2 4 4		80–140–160 80–160 40–80 40	600	Yes, for motor car; no, for trailer.	Electric	Yes		Air		Motor-driven compressor.	Brake cylinder
3	43	15	.55	7.0%	116	4		140	600	Yes	None	Yes	No	Air		Motor-driven compressor from traction power.	Brake cylinder

Company No.	Mileage: Per day	Mileage: Per year	Length of run (miles): Passenger	Length of run: Freight	Length of run: Mixed	Reasons for electrification of this service	Do climatic changes present problems?	Type of contact system: Catenary	Type of contact system: Direct suspension	Type of contact system: Third rail	Normal height above track	Voltage	Type of collector: Pantograph	Type of collector: Trolley wheel	Type of collector: Third rail shoe
1	898	327,794	34.51			Economy	Slight snow interference.	Yes			21′-0″	11,000	Yes		
2	2,026 290 540 30	739,000 106,000 196,000 10,900	19.4 6.8 9.4 4.4	0 6.8 0 0		Economy; all are short branch lines feeding main line steam operated R. R.	Snow and sleet		Yes		22′-0″	600 D. C.		Yes, Miller shoe	
3	19,600	3,869,273	8.3			Quicker acceleration, resulting in reduction of running time; increased flexibility of operation; reduction of noise and smoke in congested districts; reduced operating costs.	No	Yes			22′-0″	1,200 D. C.	Yes		

Storage battery locomotives have been developed for industrial yard switching to some extent but their use is extremely limited. Those in service weigh from 20 to 40 tons and have tractive efforts up to 16,000 lb. on a one-hour basis. Lead cells are generally used for this class of equipment, usually at 200 volts and with capacities up to about 1,000 ampere-hours.

Much remains to be done in connection with the collection of information on self-propelled cars, and the committee recommended that consideration be given to continued study of this interesting subject.

Review of Committee Work for Past Three or Four Years, Supplementing as May Be Deemed Proper

The work of the committee during the last three or four years has been largely the collection of data and information, and considerable effort has been made to keep away from the controversial subjects upon which formal

decisions or recommendations would probably be somewhat difficult. On this account the reports have perhaps been somewhat incomplete. It was felt, however, that this was unavoidable and that specific recommendations were impossible on account of inadequacy of data at the present time. This condition will disappear with the extending of electric operation, and opportunities for standardization of catenary construction, locomotive design, etc., may present themselves in the not distant future.

During the past few years the development of heavy electric traction has been of necessity somewhat slow on account of lack of funds available for expansion. Many railroads, however, have actively considered the question of electrification as a solution for their individual problems, and several engineering investigations have been completed and plans made for electrification, some of which have been delayed pending more favorable conditions.

The Norfolk & Western Railroad has completed and placed in operation an extension of its electrified zone from Kimball to Farm, a distance of about 20 miles, involving about 50 miles of single track. The road has purchased four additional locomotives to take care of the extension. These are to weigh about 385 tons each. They are of split-phase type, as are the present locomotives, the principal difference being that the phase converter on the new locomotives is a synchronous machine which permits the attainment of virtually unity power factor at all times. The wheel arrangement is 2-8-2 + 2-8-2, the halves of each locomotive being symmetrical and interchangeable. Each half has two motors, with a gear ratio of 21 to 100. The drive is by means of side rods and jack shafts. The continuous tractive effort at 14 miles per hour is to be about 90,000 lb. with an hour rating of about 108,000. The four motors are rated at 1,000 hp. each.

The Pennsylvania Railroad is building three locomotives with identical series-wound, commutator motors. Two will operate on 600-volt third rail in terminal service in New York and the third, equipped for single-phase operation, will be run between Philadelphia and Paoli.

The New York, New Haven & Hartford Railroad has purchased 12 new passenger locomotives of a type similar to those placed in operation in 1919. The wheel arrangement is 2-6-2 + 2-6-2 and the weight is to be approximately 180 tons. They are to have six pairs of twin motors with a gear ratio of 25 to 89. The continuous tractive effort at 40 miles per hour is 15,800 lb. The maximum tractive effort will be about 52,500 lb. The maximum safe speed will be 66 miles per hour. They are adapted to operation from the single phase trolley at 11,000 volts and from either an over-or-under-running third rail at 650 volts.

The Pennsylvania, the Long Island and the New York Central have each purchased considerable new multiple-unit equipment.

The Illinois Central, after an exceedingly thorough investigation, has completed general plans for the electrification of its tracks at its Chicago terminal. The electrification will involve the main line to Matteson, the South Chicago branch, and the Blue Island branch; about 37 route-miles and 125 miles of track. The system will be 1,500 volts, direct current, carried in overhead trolley.

The Virginian Railway has started electrification of its line from Roanoke to Mullens, a distance of about 134 miles, involving 213 miles of single track. The traffic is nearly all coal and very heavy trains are hauled. It is planned to increase the tonnage of loaded coal trains to 9,000 tons. The system will be 11,000 volts, single-phase, 25-cycle. The locomotives will be similar to those purchased by the Norfolk & Western Railroad.

It is of interest to note the continuing upward trend after an interruption in growth of electrification. This reflects not only somewhat improved financial conditions but a recognition of the relative ease of maintaining electric locomotives as compared with steam locomotives under adverse labor conditions.

The members of the Committee on Heavy Electric Traction are as follows: A. H. Armstrong, R. Beeuwkes, J. M. Bosenbury, H. W. Cope, J. H. Davis, J. V. B. Duer, E. C. Johnson, Norman Litchfield, A. S. Richey, C. H. Quereau, L. S. Wells, H. A. Johnson, John C. Davidson, vice-chairman; Sidney Withington, chairman.

Progress in Mexican Electrification

Orders have been placed with the International General Electric Company for a 11,250 kva. 4,000-volt waterwheel generator to furnish power for the electrification of the Maltrata Incline of the Mexican Railways, contract for which was let to this company recently. More than 50,000 kva. in water cooled 60-cycle transformers designed for 42,000 volts primary are also included in this order. This is the second important step in beginning electrification. Reports from Mexico City already indicate rapid progress in the erection of

Where Rail Poles End Just Out of Orizaba Yard and Concrete Poles Begin

the overhead line. This will be carried on concrete poles for part of the distance and on special steel poles for the remainder. The latter are of novel construction, being built from discarded steel rails, a large number of which were on hand. In the construction of the poles, arc welding sets are being used with great success. The poles are set in concrete foundation and make a very presentable appearance.

Shipment has been completed from Schenectady and Erie of the overhead line equipment, including trolley wire, feeder hangers, etc.

The 3,000-kw. 3,000-volt motor generator sets for the

substation to be located near the center of the electric division will be the largest ever constructed for this voltage. These are now being assembled for test while the locomotives are themselves nearing completion at the General Electric Works at Erie, Pa. All of the locomotives will be tested on the experimental tracks before shipment. These tests will include a thorough tryout of the regenerative braking feature as well as the usual hauling tests.

J. B. Cox, General Electric engineer, left for Vera Cruz on September 4, to be gone about six weeks. He will supervise the further installation of the electrical equipment.

P. R. R. Combination Car

The new all-steel combination cars for the Pennsylvania, Class PB-70, built at the Harlan plant of the Bethlehem Shipbuilding Corporation, Wilmington, Del., have a passenger compartment 34 ft. 9⅝ in. long, with seats for 44 persons and a baggage compartment 35 ft. 6 in. long. The length of the body is 77 ft. 8¾ in. The weight of the car is 134,600 lb., of which the two trucks constitute 45,900 lb. These trucks, which are of the Pennsylvania patented six-wheel type, Class 1-D, have

Interior of Pennsylvania Combination Passenger and Baggage Car

36 in. steel wheels, 5½ in. by 11 in. journals and a wheelbase of 11 ft. 0 in.

The interior finish, including the ceiling, is in steel with Ceilinite on the back. The flooring is of Flexolith composition. The seats are Hale & Kilburn No. 194. Parcel racks of the continuous type are provided. Window fixtures and trap doors are of O. M. Edward's design.

The Gold Car Heating & Lighting system of steam heat is used in the passenger end and the Vapor Car Heating & Lighting system in the baggage end.

The Lighting Equipment

The generator of the new cars is the U. S. L. type C. B. H. form 17, which has a capacity of 2.25 kw., 50 volts, 45 amperes. The P. R. R. type of body suspension and tension device is used. The generator, which is suspended from the baggage end of the car, has a pulley 8 in. in diameter while the axle pulley has a diameter of 14½ in. The shaft upon which the generator swings is equipped with grease cups, one at each end for lubricating the suspension bearings.

The generator regulator panel is the U. S. L. type C. P. form 233 and the lamp regulator panel is the U. S. L. type B form 33.

Sangamo control panels equipped with Sangamo meters and with the P. R. R. type of circuit breaker are used which is the standard for all Pennsylvania cars.

The regulator cabinet which is located in the toilet contains a Sangamo control panel, the generator panel and the lamp regulator while the switchboard cabinet which is located in the bulkhead at the passenger end of the car contains a Crouse-Hinds 4-circuit switchboard. The lighting fixtures in the baggage end of the car are plain, straight fixtures with porcelain reflectors and in the passenger end new pedestal type fixtures are provided with No. 18226 Holophane reflectors. The car is lighted by ten 50-watt and four 15-watt lamps. The 50-watt lamps are equally distributed along the centre of the car, five being in the baggage compartment and five in the passenger section. One 15-watt lamp is located in the toilet, one in the bulkhead and two over the steps leading to the platform of the car.

There are four control switches in the switchboard cabinet. Switch No. 1 controls the lights in the bulkhead, toilet and one of the 50-watt lamps in the centre of passenger compartment while switch No. 2 controls the other four lights in the passenger section. The first, centre and fifth lights in the baggage section are controlled by switch No. 3 and the other two lights in this section by switch No. 4.

For the convenience of the baggage-men, a double-pole, double-throw push button switch is located over the side door in the baggage end and also controls the first, third and fifth lights in the baggage compartment.

The batteries used in the new machines consist of 25, type A-4-H Edison cells.

Open Observation Car in Canadian Rockies

Car Lighting Maintenance on the Illinois Central

Axle-Light Equipment with Nickel-Alkaline Battery is Standard—Overhauling Done as Car Goes Through Shop Every Sixteen Months

THE Illinois Central has approximately 540 cars in passenger train service that are equipped for electric lighting. The 32-volt axle lighting system with a battery on each car is standard, there being a train line connection installed which is used only in case of emergency.

A 3-kw. body hung generator is the standard unit used on all coaches and mail cars. On a few diners, parlor and lounge cars a 4-kw. generator is used. On coaches the battery has a capacity 225 ampere-hours, while for mail cars, diners, etc., either the 300 ampere-hour set or the 450 ampere-battery is used. Nickel-alkaline storage batteries are used on practically all cars. A few of the 450 ampere-hour sets were purchased for especially heavy lighting loads but it has been found that such a high capacity is required in rare cases only. On a few suburban cars a 2-kw. low speed generator is used, giving lower cutting in speeds to offset the frequent stops in suburban service.

Fig. 1—A Block and Tackle Suspended From a Track and Trolley Are Used for Dipping the Battery in Paint

Cars Shopped Every Sixteen Months

The shopping program of the Illinois Central requires that each coach pass through the shop for a complete cleaning and overhauling at the end of every 16 months. Except in cases of accident or a rare case of battery trouble the batteries are not removed from the car except when shopped.

The carlighting repair shop is housed in a separate building located alongside the track on which cars are set while entering the shop. While the cars are on this track or soon after entering the shop, the electricians remove the lighting fixtures, and the battery. The armature of the generator, together with the brushes, bearings, etc., are removed from the generator frame, and if the field coils show any signs of being oil soaked these too are removed. Unless trouble has been reported on the controller panel it is not taken from the car but is cleaned and inspected mechanically, while in place in the cabinet. The car wiring is all tested out for shorts and grounds.

Course of Battery Inspection

As soon as the battery is taken to the battery house the dirt and old paint scale is brushed off the crates and cell cans. Any crate slats that are broken or weakened are replaced with new slats of maple or birch which have been boiled in paraffine. Having assembled the cells in new or renewed crates the complete crate is dipped in asphaltum paint up to the level of the outlets and terminals. A block and tackle suspended from an overhead track and trolley, together with a pair of hooks, as shown in the picture, assist materially in dipping cells in the paint. At other times the crate of cells is readily handled by one man, for even the largest size of 450 ampere-hour cells with four in a crate weigh only 152 lbs. As soon as the crate of cells is dipped in the paint it is set on the drain to drip and dry, as shown in the picture.

As soon as the paint is dry enough to permit handling, the battery is placed on the charging shelves, as shown in Fig. 2, and connected up in regular car lighting battery sets of 32-volts, using six crates of 4 cells each. The electrolyte is then brought up to the proper level by adding distilled water.

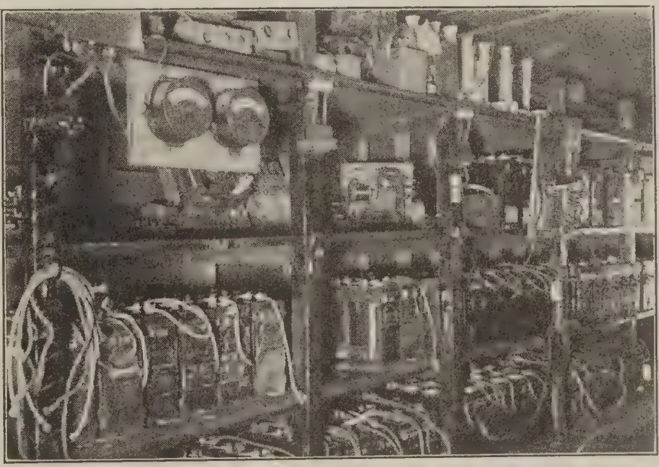


Fig. 2—Battery on Charging Shelves—Note Charging Line in Conduit Above, with Charging Meter to the Left and Discharging Rheostat and Meter to Right

Battery Charging and Testing

A 220-volt d.c. circuit from the shops is used, together with the bank of grid rheostats, as shown in Fig. 1, for battery charging. This charging circuit is carried in conduit to six terminal connectors, shown on the posts in Fig. 2. These outlets are connected in a series circuit and ordinarily 3 or 4 sets are charged at one time, thus utilizing the major part of the 220 volts available and thus reducing the loss in the rheostats. When charging,

those outlets not in use must be shorted with special plugs. The voltmeter and ammeter connected in the charging circuit are shown to the left in Fig. 2.

The 2-hour discharging rate for the 150 ampere-hour cells is 20 amperes; for the 175 ampere-hour cells, 28 amperes; for the 300 ampere-hour cells, 38 amperes; and for the 400 ampere-hour cells, 48 amperes. The voltage of each cell is read every 15 minutes. If the cells hold up the voltage properly the crates are checked o. k. and set out ready for the next car coming out of the shop.

Providing the battery is sluggish and does not build up promptly, it is placed on a high rate of discharge until exhausted, and is then charged quickly at a rate higher than normal. Two or three such cycles usually work the cells back to the proper operating condition. In rare cases, individual cells are removed from service for further tests or replacement. The portable voltammeter attached to the same board as the rheostat, shown hanging to the right in Fig. 2, is used for discharging.

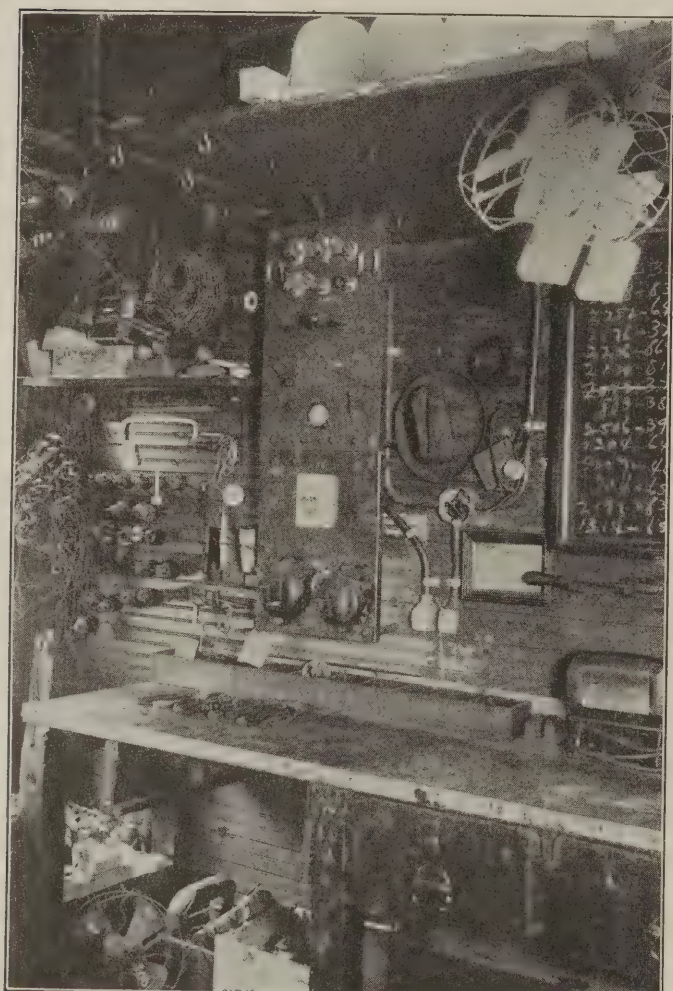


Fig. 3—The Maintenance and Repair of Electric Fans Is Concentrated on One Bench

On an average, batteries, for 30 cars, that is, 180 crates, are handled in this shop every month. One man alone handles all of the battery work and oftentimes assists on other work.

Control Panel and Generator Repairs

The control panels are cleaned and inspected for mechanical defects while in place in the cars. If any repairs are required the panel is removed to the repair shop shown in Fig. 3, where tests, repairs and replacements are made.

As previously mentioned the generator is disassembled, leaving only the generator frame on the car body. The armature wiring is tested for grounds; if the commutator is rough it is dressed down and the coils are painted with insulating varnish. The bearings, brush holders, brushes, etc., are cleaned and overhauled. The generators are assembled on the coach about the time the car is ready to be released from the shops.

Fixture and Fans Overhauled

The lamp bulbs, reflectors and shades are all removed from the cars, cleaned and replaced in first class condition when the car comes out of the shop.

Due to the fact that the main line of the Illinois Central runs south to New Orleans it is standard practice to use at least two 12-in. bracket and two 4-blade ceiling fans in the coaches, and four or more in the dining cars, club cars, etc.

The lower half of the test panel shown above the work bench in Fig. 3, is fitted especially for testing bracket type electric fans. At the bottom are mounted two of the older types of fixed wall brackets to be used for supporting these types of fans when they have been removed from cars by lifting from the sockets. The white oblong terminal unit in the center of the panel is a standard terminal fan mounting that permits the removal or replacement of a fan without making any wiring connections, the circuit being made by the set of contacts shown when the fan is set in place. On account of the long season of service required of fans on this road the bearings are given a thorough cleaning and inspection, the commutator and brushes are brought up to first class shape before every fan leaves the shop.

The upper section of the panel in Fig. 3 is used for lamp and fuse testing. Either 110 volts a.c., 220 volts d.c or 32 volts d.c. is available. The two diagonal copper strips at the right are the terminals of a circuit in series with the lamp above. Fuse, lamps, etc., are readily tested by touching across these two strips to see if the lamp lights.

Complete Electrical Inspection

After all of the carlighting equipment has been replaced on a car and before it is released from the shop, a thorough inspection is made of all electrical apparatus. The height of the solution in the battery is checked and the generator belt is tightened.

Road Maintenance

In view of the fact that the carlighting equipment is so thoroughly overhauled every 16 months the road maintenance is reduced principally to making adjustments of regulating equipment, inspecting belts, flushing batteries and renewing lamps. However, a large part of the running repairs are handled at the Weldon coach yard at 19th street, Chicago, and inspections are also made at other terminals, such as Omaha, St. Louis, New Orleans, Memphis, etc.

The Massachusetts Department of Public Utilities has suspended for one month from October 15, the tariffs filed by the principal railways of the state announcing increases in the rates for commutation tickets.

I. C. C. Report on Sprague Train Control Tests

Conclusion Is Warranted That a More Extensive Installation Be Made and System More Fully Demonstrated

JOINT observations and tests by the Bureau of Safety of the Interstate Commerce Commission and the American Railway Association have been conducted on the Sprague Safety Control and Signal Corporation's automatic train control device in the laboratory and shop of that company at New York and as installed in the electrified zone of the New York Central lines between Ossining, N. Y., and Tarrytown, N. Y. An abstract of the joint report of the inspectors of the Bureau of Safety and the A. R. A. is given as follows:

On May 12, 1921, at a joint meeting of representatives of the Interstate Commerce Commission, the American Railway Association, the New York Central, and the Sprague Safety Control and Signal Corporation, arrangements were agreed upon for conducting a test of the Sprague device upon the New York Central. The official road test began on May 1, 1922, and ended January 31, 1923. During the official test the locomotive apparatus was sealed by the Bureau of Safety. May 1 to November 20, 1922, was considered as a development period, and November 21, 1922, to January 31, 1923, was considered as a service period. This report is based upon test made during the latter period. A description of this apparatus and installation was published in the *Railway Electrical Engineer* for May, 1922, page 151.

Analysis of Tests

In recording the performance of this device the movement of the locomotive over each track magnet was counted as an operation when the device was in service. The operations were classified as first applications, second applications, and resets. The movement of the locomotive through a block was recorded as a test, each block being equipped with three magnets; there were normally three operations to each test (block).

When an application magnet in a stop condition (active) was passed and a brake application was initiated, the operation was recorded as a first application or second application, as the case may have been. If a brake application was not initiated, the operation was recorded as a false clear failure (operation).

When an application magnet in proceed condition (canceled) was passed and a brake application was not received, the performance was recorded as a clear operation. If a brake application was initiated, the operation was recorded as a safe failure (operation).

When a locomotive in the clear or proceed condition passed over a reset magnet in the proceed condition (energized) and there was no change in the locomotive condition, the performance was recorded as a clear operation.

For the purpose of this report all performance was tabulated so as to segregate the operations that occurred as track magnets from those occurring between track magnets, and also in unequipped territory. The performance of this device during official tests which took place from November 20, 1922, to January 31, 1923, is indicated as follows:

Equipped Territory	
Trips	145
Mileage	638
Tests	725
Proper operations at track magnets	2174
Safe failure at track magnets	1
False clear operation at track magnets	1
Unsatisfactory operations at track magnets	1
Proper high-speed operations between track magnets	23
Unsatisfactory high-speed operations between track magnets	1
Proper speed-control operations between track magnets	141
Unsatisfactory speed-control operations between track magnets	1
Reset at points tabulated by Sprague Co.	1
Reset at point not tabulated by Sprague Co.	1

Unequipped Territory	
Mileage	1554.6
Application or impulse received at points tabulated	51
Reset impulse received at point tabulated	0
Reset (locomotive) impulse received at points not tabulated	7
Reset (detector) impulse received at points not tabulated	4
High-speed operation	8
Speed-control operation	13

In addition to the foregoing, a series of standing tests were made to determine whether or not this device had any bad effect upon the standard air-brake system, and also to demonstrate the effect of leaks at gaskets and pipe connections. A number of special tests were made in equipped territory in which conditions were created for test purposes. The locomotive apparatus was also inspected and tested to determine whether or not the apparatus had changed or deteriorated materially during the two-month period covered by the tests.

A safe failure in test 1073 occurred January 26; it was a failure to obtain a reset in block 5 at a speed of 40 m. p. h. at an energized reset magnet. The cause of this failure was due to accumulative leaks at various places in the air circuits.

False Clear Failure

A false clear failure occurred on test 924 on January 17, at magnet No. 1 in block 1. It was a failure to initiate a primary brake application at an active track magnet, at a speed of 52 m. p. h. The whistle was not operated, neither was the brake valve handle automatically moved to lap position, nor was there any other evidence that the primary pilot valve magnet had been deenergized so as to initiate an automatic brake application.

The cause of this failure was attributed to a combination of circumstances; briefly, they were—track magnet not installed at the effective operating height for which it was designed; distorted application flux plates; improper assembly of one magnet bar, its polarity being opposite to that of the other magnet bars; speed that was apparently critical for the existing conditions at time of failure.

Unsatisfactory Light Operation

In tests 868, 870, 877, 885, and 886 the operation of the yellow cab indicator light was not considered satisfactory;

the light continued to burn and gave no warning that the imposed low-speed limit had been exceeded, the result being that an undesired emergency brake application was received.

The cause of the unsatisfactory operations was that the speed governor brush, which controls the brake action at low speed, became displaced in its holder.

On December 12, in test 507, it was noted that the green cab indicator light flickered and then went out at a speed of 52 m. p. h., or about 4 miles less than the maximum speed limit. Investigation disclosed that the high-speed brush of the speed governor was not making proper contact with the commutator.

This occurrence had no effect upon the device other than to require that a reset be obtained before an active application magnet was passed, else an emergency application would have occurred.

False Clear Reset

On January 30, the engineman's reset button was closed for test purposes at a point about three or four hundred feet east of the No. 1 magnet for block 3, and a reset was received while moving at a speed of approximately 15 m. p. h., the locomotive apparatus being in caution at this time.

Discussion

The track apparatus is of the normal stop type, and the locomotive apparatus is of the normal clear type. The normal stop system of the track apparatus is such as to require a minimum of battery consumption for its operation and was imposed upon the existing automatic block-signal system, which is of the normal clear, three-position, upper quadrant semaphore type. The purpose of the installation was to demonstrate the fundamental principles of the device under actual service conditions in so far as was practicable and with the minimum interruption to traffic and to the circuits of the automatic signal system.

It should be noted that this device is designed upon the closed-circuit principle; that it is assumed the permanent magnets are of such a nature that their integrity to function as intended can be relied upon under conditions of reasonable inspection and maintenance for a considerable period of time. The locomotive receiver application armature contact is based on the open-circuit principle; its contact is normally closed and depends upon energy to actuate the armature so as to operate its contact. This condition is somewhat analogous to the mechanical trip. The permanent magnets simply replace or supersede the mechanical trip or similar track apparatus.

During the inspection and checking of the locomotive circuits it was noted that a high resistance ground existed on certain wires when the headlight generator, which is part of the standard locomotive equipment, and which was utilized by the proprietor for the purpose of charging his 12-volt storage battery, was connected through the charging panel. Further investigation indicated that a high resistance ground existed on both generator leads, one being of higher value than the other. It is known and agreed to that a ground on certain portions of the reset circuit will cause the reset delay to become energized, the cause of which was traced to the headlight generator.

It was noted that while making terminal tests in Harmon yards that the reset collector plates were at times affected by stray fields so that when the locomotive was in caution condition and the reset button was closed the receiver reset armature would be attracted so as to close its contact and energize the reset relay.

Investigation failed to reveal any apparent cause for such action, other than the fact that electric motors or multiple unit cars were moving on near-by tracks, or that equipment had stopped moving, but was still drawing current for car lighting, false clear reset operations were obtained. There were no permanent track magnets in Harmon yard, and there was no visible indication of any cross bonding, cables, pipes, or any other thing that might appear to be the cause of such false clear reset performance.

During the conduct of the tests it has been demonstrated that under certain traffic conditions affecting the flow of propulsion current from or to the substations and power houses intermittent stray fields were encountered that affected the locomotive receiver in a perfectly logical manner, but certainly not as intended or desired. It has been noted that the application armature was affected at certain cross-over switches at certain times, so as to cause an undesired brake application. The reset armature has been affected at cross bonding and third-rail feeder cables, both of which cross the tracks at right angles thereto, so as to energize the reset relay as the locomotive passed over such locations while in caution condition.

It is probable that all such erratic and undesirable operations could be practically, if not completely, overcome by the installation of suitable means of protection.

One method of protection against stray reset fields at cross bonding, feeder cables, etc., was proposed in the form of a metallic screen over such cables. The installation of a normally open switch (engineman's reset button), inserted in the reset circuit in such a manner as to require the co-operation of the engineman when a reset was desired while passing over such a magnet, was thought by the proprietor to be sufficient protection against such undesirable reset fields and was in use during the official tests.

The weather conditions during the period of official tests, from December 5 to January 31, were rather severe for this section of the country. The track magnets were buried in snow and ice for weeks at a time. It was noted that this condition had no effect on their proper function. The analysis of the performance of the track magnets indicates that the electromagnets used for the reset function can be relied upon at all times to provide maximum protection. The characteristics of such magnets are well known and established and being installed entirely on the normal danger system, the absence of function as intended will result on the side of safety.

In regard to the permanent magnets, particularly in reference to the service and conditions existing in these tests, their characteristics have not yet been as firmly established as those of the electromagnets as previously stated. The permanent magnets do not have the inherent principle to provide maximum protection in case of loss of function. It is believed, however, that the loss of function is so remote that the use of such magnets is practicable and can be relied upon for the purpose intended.

The device tested demonstrated that this apparatus can be installed and interconnected with existing signal sys-

tems, regardless of whether the signal control circuits are alternating current or direct current, normal clear or normal stop, and also whether the track circuits are alternating current or direct current.

The application of this device to the varying needs and conditions of every-day freight service was not demonstrated. We are unable to express any opinion other than our confidence in the ability of the proprietor to arrange the device so that it will function in accordance with the requirements of such service.

The locomotive was not operated in territory other than where the tracks are used for the return of propulsion current, at least sufficiently to demonstrate whether or not the device would be affected by conditions existing outside of third-rail territory. It is reasonable to assume that with track magnets of greater magnetic strength the adjustment of the receiver may be such as to overcome a considerable amount of interference from stray fields.

The performance of the locomotive apparatus to function as designed and installed was satisfactory and demonstrated that a predetermined brake application can be initiated through the medium of a magnetic impulse emanating from track magnets and controlled in a practicable manner.

The speed governor is a mechanical device used to open and close the speed-control circuits. This apparatus is well constructed. An inspection at the close of the official tests failed to reveal any apparent sign of weakness of parts or of lost motion between moving parts. It is our opinion that this speed governor is an efficient device and can be depended upon to function as intended with reasonable inspection and maintenance. The relay assembly is well designed and constructed. No trouble was experienced with this apparatus, and it is believed to be an efficient device for the purpose intended. The pilot valve magnets are of the form wound type and have no unusual features different from similar types used extensively in signal practice.

Attention is again called to the necessity of proper adjustment of the receiver armature contacts, the operation of these contacts being of vital importance. A weak adjustment may result in unnecessary brake applications on account of vibration and perhaps stray fields of weaker strength; while a stiff adjustment of the application armature may result in its contact not being properly opened when passing over an active application magnet, especially at high speed. A proper adjustment of the receiver contacts is therefore imperative.

The operation of the receiver under the influence of stray fields is quite logical unless some means of differentiating between the flux of the permanent magnets and that of the stray fields can be devised. This appears impossible and the trouble or fault appears to reside apart from the receiver, which can hardly be criticized for its operation under such conditions. The remedy should be applied at the source, i. e., the track. The receiver is well designed and constructed, and during all of our tests and observations it was immune from dirt and moisture.

The pneumatic apparatus interferes in no way with the manual operation of the engineman's brake valve, and the use of this device will have no bad effect upon the standard air-brake equipment.

In connection with the false clear failure in test 924, the proprietor has recently raised the question of the varying weight of coal and water, which may affect the height of the tender above the top of the rails, and in so doing alter the height of the receiver.

The latest explanation offered by the proprietor in regard to this failure is that there were a number of contributory factors: First, the improper assembly of the magnet bars in this particular track magnet; second, the distortion of the rear end of the left-hand flux-collector plate; third, the height of the receiver may have been increased by a low supply of coal and water.

In regard to the varying height of the tender under conditions of empty and load, in our opinion it is quite necessary in the installation of such a device that proper allowance be made for the widest variation that may be encountered in every-day service. Furthermore, the operating margin of the track magnets must be great enough to insure a free field of sufficient strength to operate the receiver armature under any condition of distortion that may occur to the flux-collector plates in ordinary service.

Conclusions

While, as a whole, the observations and service tests made are not considered conclusive, it has been demonstrated that a magnetic impulse can be transmitted in electrified territory from permanent track magnets to the locomotive regardless of speed, oscillation, or weather conditions, and that such impulse will actuate the locomotive apparatus to provide automatic brake application in a practical manner.

In view of the results obtained under the conditions surrounding these tests, the conclusion is warranted that this device has such inherent merit that a more extensive installation should be made where the real value of this system can be more fully demonstrated.

Copyright by Ewing Galloway, N. Y.

New York General Post Office with Pennsylvania Station in Background, Both Built Above P. R. R. Tracks

Electric Furnaces In Tool Room on I. C.

Easily Regulated Oven Temperatures Secure Uniformly Excellent Results

AT the Burnside (Chicago) shop of the Illinois Central is a very complete equipment for the heat treatment of tools used at this shop. This equipment consists of electric furnaces and ovens for hardening and drawing purposes. For hardening high-speed steels, a Hoskins carbon resistor furnace is used, while for preheating high-speed tools and hardening of carbon steel tools a return bend coil furnace made by the Electric Heating Apparatus Company is used.

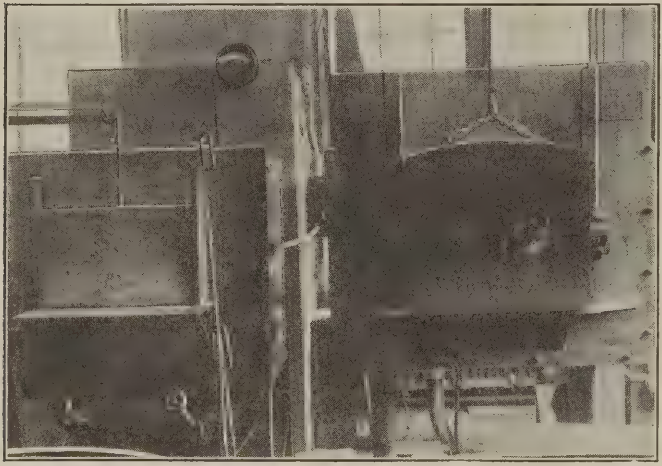


Fig. 1—Hoskin Furnace on Left and "Hevi-Duty" Automatic Furnace on the Right

The Hoskins carbon resistor furnace, shown to the left in Fig. 1, is constructed similar to the ordinary muffle furnace and the heating units are placed on the sides and the top of the chamber. The heating units consist of carbon plates placed adjacent to each other and held in contact by an adjustable screw. By varying the pressure between the plates the flow of current can be adjusted to give various temperatures. With this type of furnace temperatures in the neighborhood of 2,500 deg. F., such as required for hardening high-speed steel, are obtained. The furnace temperature is controlled manually by the operator adjusting the current flow through the heating elements. The operator is guided by the indication of an ammeter in the feed circuit, which is shown above the furnace in Fig. 1.

Fig. 2—The New Electric Furnace With the New Electric Pyrometer and Controller

For annealing and drawing tools a General Electric resistor type of furnace is used. Maximum temperature is 600 deg. and power required is 5.8 kw. The temperature is held constant by means of a Tycos pressure type pyrometer, which actuates a master switch on the control panel. The range of temperature obtained is from 300 to 600 deg. F.

Characteristic of New Coil Furnace

The Hevi-Duty type coil furnace, together with electric control and recording pyrometer shown in Fig. 2, was installed recently. The chamber of this new furnace is 13.5 in. high, 18 in. wide, and 36 in. deep. The chamber construction is shown in Fig. 3, a part of the walls being moved to show the return bend coils of No. 1. B. & S. gage wire. These coils are multiple replaceable units and all connections between coils are made outside the furnace by Frankel connectors. Wire heating elements are used on account of the greater advantages a round shape has over other forms with respect to strength and less surface oxidation. The heating coils are carried in grooved refractory Tee supports, giving a construction free to expand and contract with the temperature changes. The heat is thus applied from the sides, top and bottom, giving a uniform heat distribution in the chamber. Consequently, uniform heating of the tools is obtained in minimum time, thereby eliminating warping due to uneven heating.

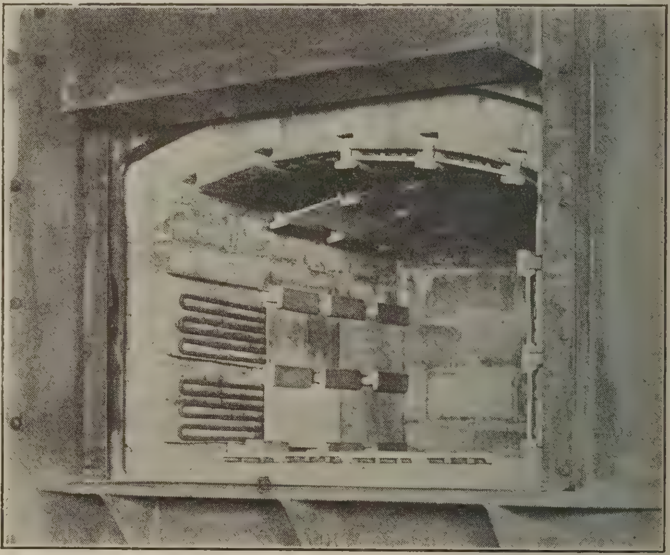


Fig. 3—Interior View Showing Loop Heating Units and Wall Construction

To protect the heating units in the floor of the furnace chamber, floor-plates, of a cast non-oxidizing metal, are

placed over the heating coils and refractory plates so that the tools or parts to be heated can be placed on the floor. The floor-plates have beveled edges and lock joints which prevents them from becoming disarranged by sliding tools or work over them.

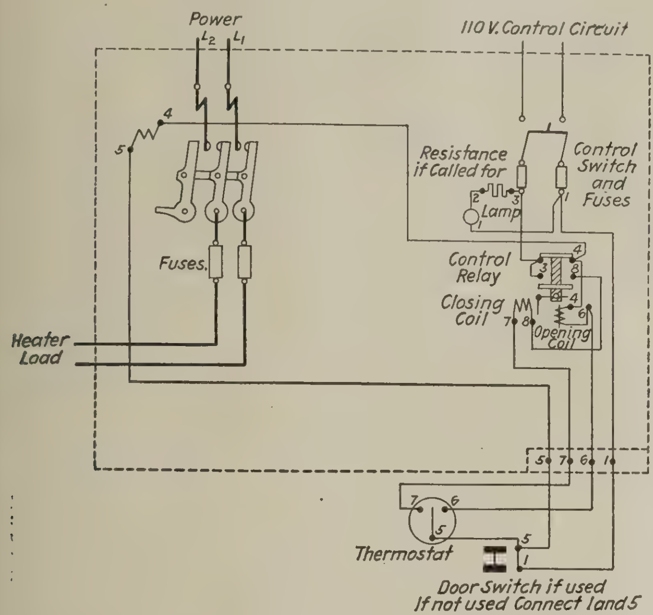


Fig. 4—Wiring of Control Panel

The safe maximum operating temperature of this furnace is 2,000 deg. F. The temperature of the furnace is automatically controlled by a Brown Instrument Company curve-drawing and contact-making pyrometer which actuates a Westinghouse control panel. The control panel is of the enclosed type, having a three-pole contactor, relay, line disconnect switch, fuses, and a reduced capacity tap switch. The circuit connections are shown in Fig. 4.


Fig. 5—The 440-Volt, 3-Phase Transformer Is Mounted Outside the Shop

The temperature in the furnace chamber can be controlled within one-half per cent of the desired temperature. Obviously, the operation of the electric furnace is a simple matter; merely setting the pyrometer at the required temperature and then pushing a button to start the furnace with no danger of the furnace exceeding the temperature the pyrometer is set for.

The power for the furnace is supplied by a three-phase transformer, shown in Fig. 5, connected in delta and having a capacity of 36 k.v.a. The primary of this transformer is 440 volts, 3-phase, 60 cycles, and the secondary voltage is approximately 65 volts. Accordingly low voltage is applied to the heating elements of the furnace, which permits the use of large cross section elements, insuring long life, and also prevents the possibility of the workman getting an electrical shock which would injure him.

With the above equipment very excellent results are obtained in the treating of tools. Temperatures are always indicated to the operator by the pyrometers and exact duplication of results are quite easily made. With the automatic control on two of the furnaces the operator is free to carry on his work on the tools without giving any time to the actual operation of the furnace other than to set the control at the desired temperature.

Justification and Prospect for Electrification*

By E. Marshall

Electrical Engineer, Great Northern, St. Paul, Minn.

The familiar reasons why railroads should electrify are: the saving in coal, reduction in maintenance cost of locomotives, and the elimination of round houses, fuel stations, water stations, etc. In the light of what the electric locomotive has done, and is capable of doing, the steam locomotive with all the above appurtenances, seems to be rather primitive. And yet we see railroads becoming more and more committed to the steam locomotive and its inherent limitations.

About 30 years ago when the Baltimore & Ohio electrified its Baltimore tunnels, they solved a very distressing problem and it was accepted at the time by many people as a forerunner of the day—not far distant—when the steam locomotive should be no more. When the other railroads started electrification, notably the New York Central and the New Haven, another inroad was made upon the steam railroad. The others that have electric locomotives are as follows: Pennsylvania—(New York City and Philadelphia); Norfolk & Western; Boston & Maine (Hoosac Tunnel); Grand Trunk (Port Huron Tunnel); Great Northern, and the Chicago, Milwaukee & St. Paul.

Operating Problems Solved By Electrification

In looking over the foregoing electrifications it appears that they were made for special reasons. In

* Abstract of paper presented before a joint meeting of the A. I. E. E. and the Western Society of Engineers, Chicago, September 10, 1923.

most cases the problem was to eliminate the smoke of the steam locomotive in tunnels or where it was otherwise very objectionable. Electrifications once started have been extended beyond the original limits, but mainly in the effort to get some benefit from the large initial investment. A five or ten mile electrification is a nuisance in that no operating expense is saved and a large addition is made to it. For an electrification to stand on its own feet, so to speak, it is necessary for it to extend over at least one operating division of the railroad.

The Pennsylvania electrification in Philadelphia was necessary since the capacity limit of the Broad Street station was reached. It was necessary to eliminate all the idle switching movements and the motor equipped passenger car is able to accomplish this to almost 100 per cent.

The Norfolk & Western had reached the limit of its capacity in a grade section and it was almost out of the question to consider additional trackage. Electrification was adopted since it was able to increase the speed about three times that of the steam propelled train, thus clearing the line for a large increase of traffic. Their neighbor, the Virginian, is about to emulate their example on a larger scale, because the limit of the steam locomotive has been reached for heavy trains on grades.

The Chicago, Milwaukee & St. Paul electrification is in mountainous sections, on which the limit of track capacity had not been reached. This road is operated in competition with other railroads handling heavier traffic by steam, and successfully so, therefore the justification for electrification of 650 miles is not fully established. Yet I know, that physically the Milwaukee electrification is a perfect success, and undoubtedly will prove a good investment ultimately.

The field of usefulness for electrification is established in those special cases where the inherent characteristics of the steam locomotive—such as smoke and hauling capacity, cannot be tolerated. Since smoke is not accounted such a great nuisance in open country and as the limit of hauling capacity is not such a serious matter on a moderate profile, the steam locomotive is still maintaining its lead and will undoubtedly continue to do so for many years to come.

Difficult to Show Saving on Large Installation

The reason that the electric locomotive is not being more generally adopted may be seen by an analysis of railroad operating costs. The operating sheet of a large railroad for a recent year shows that the operating expenses are as follows:

	Per cent
Station service	7.2
Yard service	7.1
Engine service	20.
Train service	7.2
Casualties	4.2
Miscellaneous Transportation	3.2
Maintenance of Equipment	22.2
Maintenance of Way and Structures	23.5
Traffic	1.1
General	2.6

By electrifying the road only a few of the above items would be affected to any considerable extent, viz., engine expense, maintenance of equipment, and maintenance of way and structures. The two largest items to be affected favorably are the engine expense —20 per cent and maintenance of equipment—22 per cent. If it is assumed that engine expense would be reduced 50 per cent and the maintenance of equipment 20 per cent the total operating expense would be reduced by 14.6 per cent, and to do this we must electrify the entire railroad. It would require an enormous increase in capitalization and a very large incidental increase in the item of maintenance of way and structures, which would go a long way toward nullifying the 14.6 per cent saving shown above. My conclusions are, that electrification of railways under present conditions is justifiable only in spots, and that it will be done slowly as has been done in the past.

As a means of keeping down the cost of fuel, or what amounts to the same thing, of getting more out of our fuel resources, the most promising method is the super-power systems. Provided our lawmakers do not regulate the power companies out of existence or legislate against their growth these super-power systems will develop into a supreme power system which will collect power from all possible sources even as Dr. Steinmetz has said, from local heating plants which will produce power as a byproduct of heating. On our largest railroads, carrying a dense traffic, electrified districts will take their power from the power system, while less busy railroads and districts will continue to use the steam locomotive.

Factors to Control Future Installations

Twenty-five years or more ago in advocating the use of the electric motor in shops, the argument most used was that you could save power by eliminating belts, shafting, etc., and that on Sundays and at nights it would not be necessary to run the whole shop in order to operate a lathe. Very good arguments indeed, but this alone would not have electrified many shops. Such installations have been made because of the enormously increased efficiency in the manufacturing processes and increased output, due to possibility of scientifically laying out of shops and routing the production of the shop.

In fact, the entire mechanical world has been revolutionized through electric power. The benefits were not that it saved power, or that electricity was cheaper than steam, or that a greater percentage of the original power generated was actually delivered to the tool, as is the corresponding argument for electric traction, but that it was able to revolutionize shop methods through scientific design of plant, tools and management. From the foregoing an analogy can be built up as to what may be done in transportation.

If the railways had been no more hampered by unwise legislation than other lines of industry we might now be witnessing a superior kind of transportation in which the electric locomotive would be playing a leading part. If the same kind of legislation had been applied to the great electric power companies that the railroads have suffered from, where would be the transmission lines that are now spreading over the country and delivering power to every one at unbelievably low cost? The immediate step necessary to greater use of electricity is a reduction in the activities of the legislative bodies, so that the roads may have some incentive for self improvement.

An Unusual Case of Motor Trouble

By A. Foreman

The other day I was called in on a case of trouble that had baffled the electrical force at one of the points on our system. A pneumatic tube system had just been installed in the main office building and they were having trouble with the compressor motor, a thirty-five horse-power variable speed direct-current 300 to 1,200 r.p.m. interpole motor which was subject to flashing over and, according to the ammeter readings, was apparently over-loaded.

Upon examining the motor I found the brushes to be three inches off neutral and the man in charge told me that he had moved them because the flashing was less pronounced at this position. However, the brushes on an interpole machine must always be on the neutral point and so, accordingly, I returned them to that position. The commutator was badly burned and the man informed me that he had already had it turned and slotted without result.

I then started the motor up and, working the field rheostat by hand, found that the motor operated prac-tically sparkless up to 900 r.p.m., as shown by a speed-counter, but upon moving the rheostat arm one segment farther than the 900 point it flashed over at the commu-tator. My first thought was that there was an open circuit or that the resistances were incorrectly graduated in the field rheostat, so I connected my ammeter in the field circuit (the armature circuit being disconnected for the purpose) and upon moving the rheostat arm from segment to segment determined that the field current varied gradually from 5 amperes maximum to .6 ampere minimum, which therefore proved this part of the equip-ment to be faultless.

Another possibility occurred to me—that the interpoles might be reversed—but as the tests had been made under load it did not seem reasonable that the motor would be sparkless up to 900 r.p.m. if such were the case, so I dismissed it from my mind. On further examination of the motor I found that there was a one-turn series field on two of the four poles, which amounted to about 2 per cent compounding. As it was not practical to test the polarity of the series fields by any of the methods common to the testing of small motors I checked them by assuming that the interpole polarities were correct and that the polarity of the series field on any pole should be the same as that of the interpole ahead of it in the direction of rotation. On this basis I found the series fields to be re-versed and upon changing the connections, the motor was started up and operated perfectly.

The explanation of the trouble was that the effect of the series field was not noticeable until the shunt field was very weak, due to the insertion of resistance, and when enough resistance had been inserted to bring the speed up to 900 r.p.m. the series field strength was almost equal but opposed to that of the shunt field, and upon moving the arm one step farther the two equalized, which brought about a condition of zero field strength, or zero flux, with consequent flashing over at the commutator.

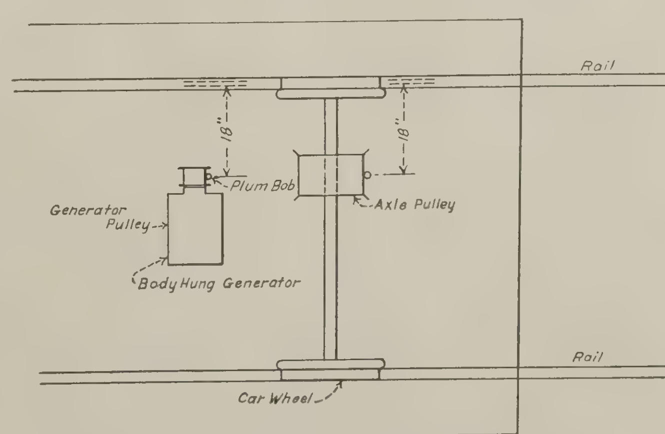
On taking a load reading I found that the motor was slightly underloaded at the highest speed, the excess current reading which originally led to the overload assumption being due to the above condition.

The machine had probably been shipped from the fac-tory with the connections wrong, because the electricians had connected it up according to the specifications ac-companying the apparatus.

Quick Method of Aligning Axle Pulleys

By W. H. Wells, Car Lighting Foreman, C. B. & Q., Chicago

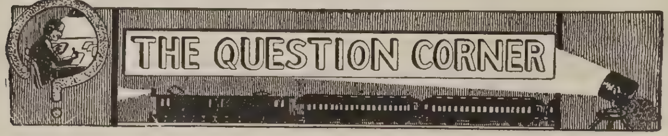
Proper alignment of the center line of the generator pulley and the axle pulley for body-hung generators is essential to eliminate extra wear on the belt and to pre-vent the belt climbing off. When changing a generator



Method of Aligning Car Lighting Pulley for Body

or axle pulley I have been using a quick method of check-ing the pulley alignment by the following method. With the car truck in normal position on average straight truck a string suspending a plumb-bob is held at the center of

the face of the generator pulley. Measurement is made from the point of the plumb-bob to the web of the rail. The string and plumb-bob is next taken to the axle pulley and the axle pulley is slipped over on the axle until the same measurement from the point of the plumb-bob to the web of the rail is attained as was found on the generator pulley.



Answers to Questions

1. *Will a 3-wire light service connected to a 3-phase watt-hour meter read a correct load? If you will note in the sketch, L 1 at the meter has only a shunt tap. Will the current consumed between L 1 and the neutral of this light service be registered on the meter?*

2. *If the same service was connected to L 2 and L 3, will the meter register a load on L 1? What I mean, is the dial on a 3-phase meter calibrated to read the load consumed on L 1 when L 1 is used for a potential tap? I think there are two load coils in a 3-phase meter; if a load of 30 amperes is taken on L 2 and also on L 3 and nothing on L 1 but the voltage, what would be the result? Would it also read a load of 30 amperes on L 1?*

3. *In the transformer bank shown, transformer No. 1 is banked as one with transformer No. 3. Wouldn't it be proper to connect neutral tap on transformer No. 3 with transformer No. 1? If fuse on transformer No. 1 blows out, wouldn't it be possible to get 220 volts on light service if circuit was unbalanced?*

4. *What would be the results if a 110-volt, 2-wire watt-hour meter were connected on 220 volts, if the shunt coil didn't burn out? Would it read fast or slow?*

* * *

Operation of a 3-Phase Watt Meter on a Combination of Power and Light Circuits

1. With reference to question 1, it should be noted that a 3-phase watt-hour meter is not suitable for use on an ordinary 3-wire light surface; and therefore, the single phase 3-wire meter should be used and not a 3-phase meter. The current consumed between L 1 and the neutral of the light surface would not be registered on the meter as it would not pass through the current coil and hence could have no effect upon the reading.

2. It will be noted for the same reason as given above if the surface were connected to L 2 and L 3, the meter would not register a load on L 1. The meter could not be calibrated to read a load consumed on line 1, when it is only a potential tap, for the reason that the meter is designed to read power and as power is the product of voltage and current, both must be taken into consideration for the meter to give correct reading. This means then that all of the current to be metered must be passed through the coils of the meter in order to obtain a correct reading. There are usually two current coils of the meter and the two potential coils of the meter in effect constitute two single phase meters connected on to the same shaft so that their effects are added. With reference to the last part of question 2, if a load of 30 amperes on L 2 and L 3 were taken off with nothing on L 1 but the voltage, the result would be that the meter would read the power of L 2 and L 3 only.

3. It would not be considered proper to connect the neutral tap of transformer 3 with transformer 1 although it would not do any harm. In the latter part of this question, it is not clear which fuse is meant, whether the high tension fuse, or one of the line fuses

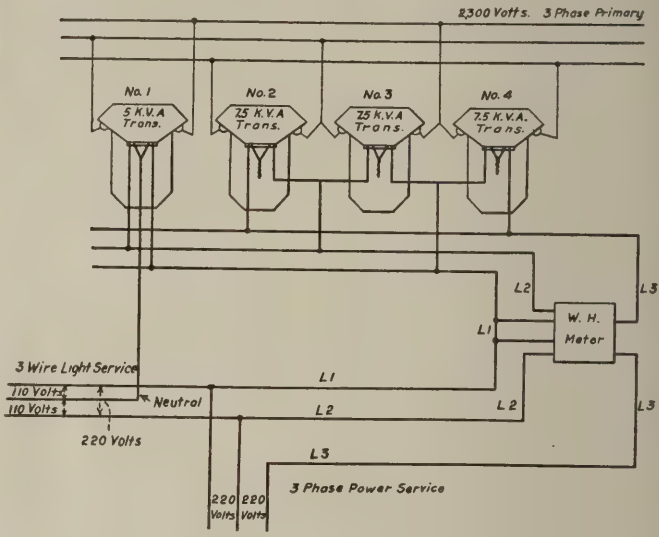


Diagram of Circuits for Watt Meter Problem

on the low tension side, or the neutral fuse. The only danger of high voltage would occur if the fuse was put in the neutral and the neutral should be opened. It is not customary or proper to fuse the neutral.

4. If 110-volt, 2-wire watt-hour meter were connected to a 220-volt circuit, the shunt coil would, of course, burn out. Until the coil did burn out, however, the meter would register correctly. The meter would run twice as fast as it would on a 110-volt circuit but as the power is twice on account of double voltage, you will see that this would be correct, assuming, of course, the same current.

* * *

Questions for October

1. *If two compound wound generators are connected in parallel on a switchboard with an equalizer between them and the steam on one driving unit be shut down while its generator switch is still in, would this generator, when run as a motor, run in the same direction or the reverse?—F. W.*

2. *What conditions would have to exist to cause the shunt field fuse of an axle generator to blow on account of a sticking dash pot?—R. A.*

3. *I am keeping in repair quite a number of steam turbines of the Pyle National type which are used on a steam pressure from* 125 *lb. to* 200 *lb. at* 3600 *R. P. M. For testing I have available only* 75 *lb. to* 85 *lb. air pressure. I should like to know at what speed I must set the governor with* 85 *lb. air pressure to obtain the speed of* 3600 *R. P. M. when the turbines are returned to the locomotives and are operated on* 125 *lb. to* 200 *lb. steam pressure?—W. L. G.*

NEW DEVICES

Electric Tire Heater

A special portable transformer for heating wheel tires electrically has been developed by the Ateliers De Construction Oerlikon, Oerlikon, Switzerland. The apparatus is suitable for the heating of tires, gears, shrink rings, etc.; which work is generally done in an oil fire and occasionally by means of a gas, coal or coke fire, the tire or gear being heated until its diameter is expanded sufficiently to permit the shrinking of the same onto the wheel center. A disadvantage of the usual method as compared with electric heating is the lack of cleanliness, uniformity of heating and exact and proper heat control. The electrical apparatus has the added advantage that a single machine can be used to heat tires of any diameter.

The device consists essentially of a transformer with a single primary winding. The transformer core has two vertical legs, a permanently connected yoke at the bottom which is mounted on four small wheels, and an upper movable yoke which can be pivoted on either one of the two vertical legs. The primary coil is placed around one of the vertical legs.

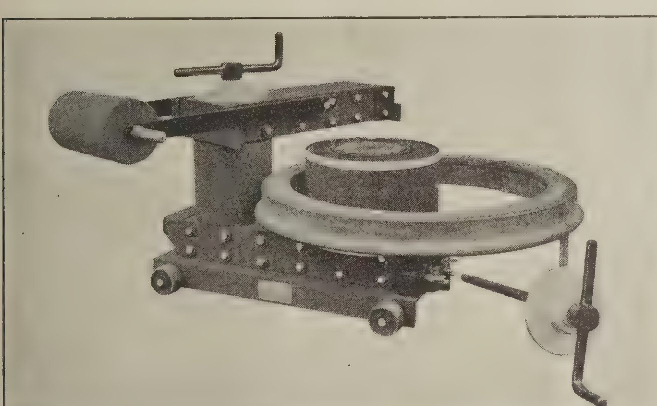


Fig. 1—Electric Tire Heater in Position for Applying or Removing Tire or Shrink Ring

When a locomotive tire is to be heated, the movable yoke is swung to one side as shown in Fig. 1 and the tire is placed around one of the vertical legs. The movable yoke is then swung into position as shown in Fig. 2 and the two screw clamps placed in the position shown and tightened so as to effectively close the magnetic circuit. Single-phase alternating current is then connected to the primary coil, the tire then becomes a short-circuited secondary with a single-turn coil and a heavy short circuit current flows through the locomotive tire and heats it. The heating is uniform and can be regulated between wide limits by means of taps on the primary windings. Objects which have a diameter smaller than that of the primary coil can be heated by placing them around the other vertical leg of the transformer. To accomplish this, the counterweight is lifted over the two tightening screws to the opposite side of the movable yoke and the left hand screw is removed instead of the one on the right.

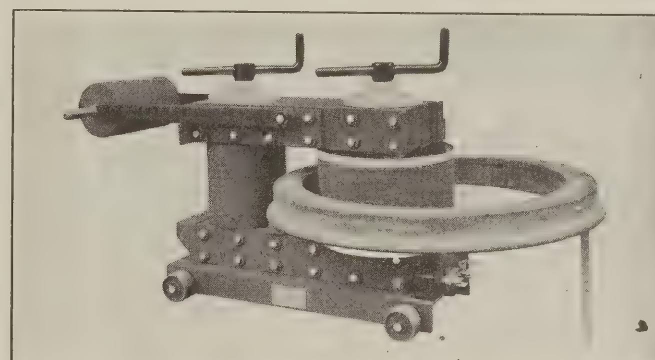


Fig. 2—Locomotive Tire on Electric Tire Heater in Position for Heating Tire

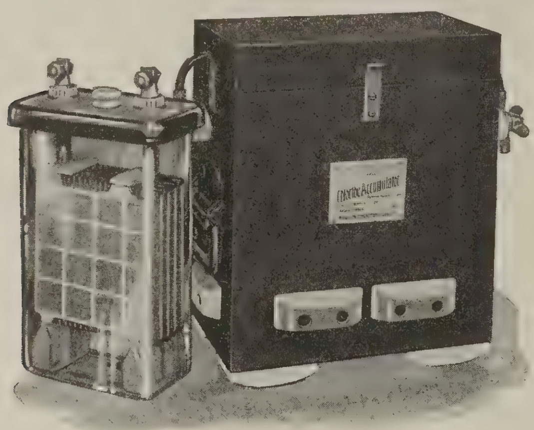
A 72-in. locomotive tire weighing 1,230 lb. can be raised from a temperature of 17 deg. C. to a temperature of 119 deg. C. in 20 min. This difference in temperature causes an expansion of about 1/10 in. in the diameter of the tire and the power consumption for doing the work is 12.2 kw. hrs.

Batteries for Train Control and Signal Service

Announcement is being made by the Electric Storage Battery Company, Philadelphia, Pa., of two new storage battery assemblies for use in the railway field. One of these batteries, type DMG, is designed for use as a floating battery for signal systems and the other, type DMT, is designed for use on the locomotive in conjunction with automatic train control. Both of these batteries are made up with Manchester positive and box negative plates.

The signal battery, type DMG, is tightly sealed in glass

jars so that it should not be necessary to add water more than twice a year. Provision is made for the escape of any gas through a small hole in the vent plug and any acid spray is trapped and returned to the cell. This feature of design is included so that the battery can be used in the same compartment with relays or other delicate mechanisms without danger of injury. This in effect constitutes a factor of safety, as where batteries receive a trickle charge, as for instance in the A. C. floating system, the possibility of gassing is remote. The battery can be obtained in single cell units containing from 3 to 9 plates and in capacities, at service rates, of from 28 to 112



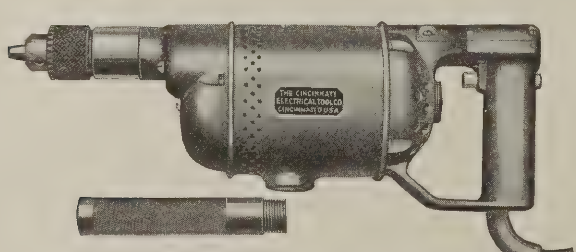
E. S. B. Type D M G Storage Cell for Signal Service and Type D M T Battery for Train Control Service

ampere hours. The weight per cell varies from 25 to 48 lb. The overall height of the battery is 14⅜ in.

The automatic train control battery, type DMT, is similar to the signal battery, but because it must be used on a locomotive, jars of Giant Compound are used in the place of glass. The type DMT battery can be obtained in from 3 to 10 cell units with 3 to 7 plates per cell. At the 8-hr. rate, the ampere hour capacity of the 3-plate cell is of 20 ampere hours; the 5-plate cell, 40 ampere hours, and the 7-plate cell, 60 ampere hours. The weights of the train control batteries as made up vary from 30½ to 180 lb. The height overall, including insulators is 15⅛ in.

Ball Bearing Hand Grinders and Drills

The Cincinnati Electrical Tool Company, Cincinnati, Ohio, has recently added to its line of portable electric drills, grinders and buffers a new series of improved high-power drills, in ¼-in., 5/16-in. and ⅜-in.



Portable Electrical Hand Drill—Air Cooled, Ball Bearing

capacities, all of which are equipped with ball bearings and air cooled. They are high-speed, production tools for continuous duty, with universal motors, for use on either direct or alternating current. The housings and end caps are constructed of aluminum to give the lightest weight possible.

The armature shaft and also the gear studs are mounted on ball bearings to reduce the friction load to a minimum and increase the power. A patent make-and-break switch is conveniently located in the pistol grip handle, and has a 50 per cent overload allowance.

These drills are furnished complete, with a three-jaw geared chuck, rubber-covered cable, steel-clad non-breakable attachment plug and extra detachable side handle. They are sent out complete, ready for the work. It will be noted from the illustration, that they are particularly adapted for close corner work.

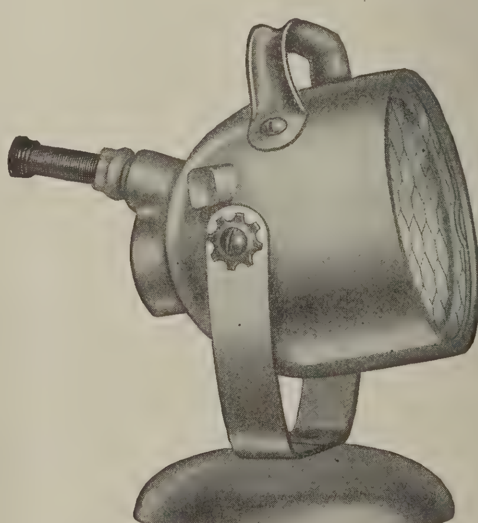
The Cincinnati Electrical Tool Company, has also developed a series of universal motor hand grinders and

Cincinnati Universal Motor Hand Grinder and Buffer

buffers, in ¼ and ½-hp. capacities. The housings, and caps, extension and wheel guard, are made of aluminum, as in the case of the drills to give the lightest weight possible. They are equipped with ball bearings throughout, so as to reduce friction and give the maximum power. These machines are particularly adapted for grinding, buffing and polishing of all kinds, and any kind of wheel, buff, or wire brush can be used.

Portable Protected Lanterns

Two portable protected lanterns have been added to the list of equipment manufactured by the Crouse-Hinds Company, Syracuse, N. Y. The type LM lantern, shown

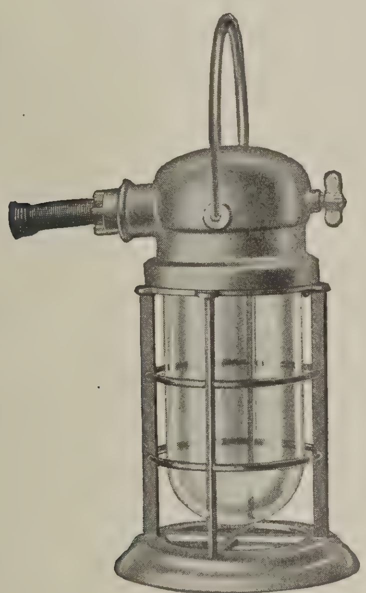


Type L M Lantern for Use in Coach Yards, Enginehouses, Shops and Freight Transfer Terminals

in one of the illustrations, is a convenient, portable, inspection lamp designed particularly for use in railway coach yards, enginehouses, shops and freight transfer

terminals where a strong, well protected portable lighting unit is needed for work or inspection. The body is made of cast aluminum and is attached to its support through a joint with a friction adjustment which permits the light to be directed up or down to any desired angle. A stop prevents swinging the body beyond the vertical position and thereby prevents twisting of the lamp cord. Substantial support is provided by a cast iron base so that the lamp cannot be easily upset. The base and handle are galvanized. The wire glass front is held against a gasket by a spring wire retaining ring and can be removed easily when it is necessary to renew the lamp.

The type of VSB lantern is a vapor-proof unit which can be used wherever combustible vapor, gas or dust is present. The body is aluminum and the guard, which includes a base, is made of brass with a galvanized finish.



Type V S B Portable Protected Vaporproof Lantern

The lantern has a swinging bail, a water-tight cord outlet with cord reinforcement to prevent chafing of the cord, and a water-tight operating handle for the key receptacle. The globe permits the use of any lamp up to and including a 75-watt lamp. Colored globes can be furnished if desired. The guard and globe are easily removable for replacing lamps and the base gives the lantern substantial support when placed upon the floor or ground.

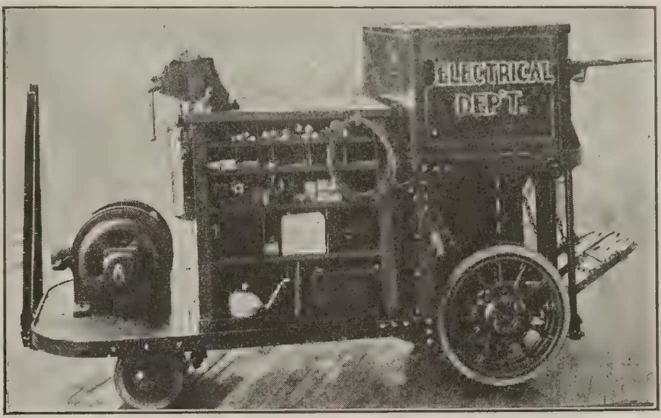
New Electric Trucks

A truck designed to meet the needs of millwrights or electricians in the performance of emergency service around shops and factories has recently been developed by the Elwell-Parker Electric Company, Cleveland, Ohio. It provides handy working facilities for the electrician or pipefitter, whose work is of necessity performed in various locations.

The truck is in reality a small movable repair shop. It is equipped with a steel and wood case that occupies about two-thirds of the platform, while the balance is reserved for a motor and tool kit. The truck may be driven at three times walking speed and provision has been made for one or two men to ride. A pipe vise is mounted on the partition rack to accommodate the usual emergency equipment.

The truck is driven by a battery carried in a large compartment located over large rubber tired driving wheels. The operator stands on a small platform consisting of two pedals. The truck cannot be started unless the operator is on the pedals and it will stop within its length if he steps off.

Another truck brought out by the same company is equipped with a fork lift designed to pick up objects



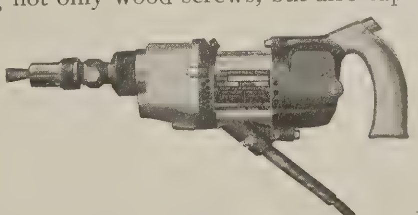
Emergency Repair Truck

set close to the floor. The load is carried ahead of the front axle.

Two other trucks have also been placed on the market by the company, one of these is of the platform lift type which will raise a load at a rate of 3½ in. in 10 seconds and the other is of the crane type. The crane truck is especially designed for stacking stores.

Screw Driving on Rapid Production Basis

Driving screws has always been more or less of a problem, as the common methods by which screws are driven in wood or metal have invariably slowed down production. To overcome this difficulty the engineers of the Independent Pneumatic Tool Company, Chicago, Ill., have developed and perfected a device for the rapid driving of screws in production work. This device, known as the Thor screw driver attachment, is fastened to the spindle end of a small size portable electric drill, which has a speed suitable for driving not only wood screws, but also cap screws and



Thor Electric Drill and Screw Driver Attachment

any other machine screws. It will drive screws of all sizes, a No. 6 or a No. 18 wood screw equally as well, with one size attachment. Above the No. 18 screw, a heavier attachment is used. It has been demonstrated in various shops that any man, without special mechanical ability, can after short practice drive 50 to 60 ordinary No. 14 wood screws a minute.

The Thor screw driver attachment is well adapted for use in freight and passenger car shops, and in fact wherever there are screws, nuts, studs, or anything having threads to drive.

General News Section

W. H. Swift, Jr., has been appointed radio engineer of the Canadian National with headquarters at Montreal, Quebec.

The Wabash Railway roundhouse at Hamilton, Ill., was destroyed by fire on September 19. Two engines were damaged and a quantity of tools and supplies was lost.

The California Limited of the Atchison, Topeka & Santa Fe was derailed near Hot Springs Junction, Arizona, on September 20, and four trainmen were killed. The locomotive and the first three cars left the track.

Shopmen on the Cincinnati Northern, including machinists, boilermakers, blacksmiths, sheet metal workers, electrical workers, carmen, helpers and apprentices, have been granted an increase in wages of three cents an hour. This increase is retroactive to August 1.

The Moffat Tunnel Commission has rejected all bids submitted for the construction of a tunnel through the continental divide west of Denver, Colo., reported in the *Railway Electrical Engineer* of September and has invited all bidders to submit offers on the project on a "cost plus" basis.

J. A. Queeny, for many years special representative of the Railway Department of the General Electric Company at Schenectady, has resigned from that company as of September 1, to accept the position of assistant to T. E. Mitten, chairman of the board of the Philadelphia Rapid Transit Company.

The Packard Electric Company, Warren, Ohio, has recently broken ground for a new factory which, in addition to facilities of our present plant, which will be remodeled, will more than double the present manufacturing capacity. It is expected that the new plant, which will be used for the manufacture of automotive cable, will be in operation January 1, 1924.

The American Railway Signals Company, sole licensee of the Julian-Begg Signal Company, manufacturer of cab signal and train control systems, Vincennes, Ind., has recently issued an attractive bulletin of 18 pages descriptive of this company's system of automatic train control. The bulletin is well illustrated to show the parts of the system and its application to railroad service and also shows circuit diagrams.

The Train Control Corporation of America has been organized with headquarters at 1409 Grand Central Terminal, New York City. F. B. Lincoln is president and general manager, Col. H. B. Hunt, director supervising, manufacturing and air brake engineering, George Sergeant, Jr., director supervising contracts and installation and Bruce J. Delette is secretary and treasurer. The corporation has taken over the Clifford Automatic Train Stop Company, proprietor of the Clifford automatic train stop. The company has a branch office in Scranton, Pa., and an engineering office at Port Jervis, N. Y. Preparations are being made for a test of the Clifford devices on the Erie near Port Jervis.

The Hudson Automatic Train Stop

This is the name of an apparatus, fixed on a locomotive of the Richmond, Fredericksburg & Potomac Railroad, which was exhibited to a number of railroad men at Potomac Yard, Va., about five miles from Washington, D. C., on Sept. 21. This is an intermittent contact device, the ramp being fixed close to the running rail. The contactor on the locomotive is a wheel 20 in. in diameter and 8 in. wide. This wheel rides upon the running rail constantly and when it reaches a ramp, is lifted and rides on the ramp. Connected with this wheel is a scraping contact or shoe which, normally 4 in. above the running rail, is pressed downward when it comes to the ramp and thus insures a clean surface for electrical contact. The ramps, of angle iron, are 30 ft. long and stand 1⅞ in. from, and 1¼ in. higher than, the running rail. The ramp is fastened to the running rail by hardwood brackets held with iron bolts. R. F. Hudson, 500 Hibbs Building, Washington, D. C., is vice-president of the company.

Progress Report on South African Electrification

The monthly report of the general manager of the South African Railways & Harbors, gives the following data with reference to electrification work undertaken on the railways' Natal main line.

At Colenso power house 21,800 cubic yards of excavation work had been carried out, 15,700 cubic yards of concrete placed in position and 20 tons of steel work had been erected. A contract for 1,000,000 bricks has been placed with a South African firm.

Alterations to stations have been completed at Colenso, Naval Hill, Heavitree, Lowlands and Ennersdale. Work is proceeding at 13 others.

Survey work for the route of the transmission line has commenced.

Material to the extent of 926 trucks were dealt with at Colenso during the month.

At the end of April, 400 Europeans and 2,005 natives were engaged on the electrification work.

Railway Electrification in Brazil

A contract for the electrification of the Campos de Jordão Railway in Brazil, which has been awarded to the English Electric Company by the government of São Paulo, includes the electrification of an existing metre-gage railway, the supply and erection of some 15 miles of 30,000 volt three-phase transmission line and of about 30 miles of overhead catenary construction on the 1,500 volt d. c. system, the construction and equipment of a substation, and the building of

motor coaches for both passenger and freight service.

At the substation the 30,000 volt three-phase 50-cycle supply current will be transformed down to 2,000 volts, and converted into direct current at 1,500 volts by a 500 kw. synchronous motor generator. The electrical equipment of the motor coaches will comprise four self-ventilated motors, each wound for 750 volts, the motors being connected two in series, and the two pairs operated in series-parallel. The passenger coaches will seat forty passengers, and the freight cars, which are to be of the covered type, will carry ten tons each.

One-third of the total route length of the line is level, but the remainder is over gradients, of which the most severe is 10½ per cent, and there are about eight miles of track on which the gradients range from 6 per cent upwards. On that account the motor coaches are to be equipped with four different braking systems—hand, air, rheostatic and electro-magnetic track brakes. The last are intended for use in emergency only.

Building Equipment Control Apparatus

A four-page booklet entitled "Specifications for Building Equipment Control Apparatus" has been published by the Electric Power Club. These specifications have to do with the requirement for motor control equipment in public buildings. The controller manufacturers associated with the Electric Power Club have presented these specifications as a summary of the best modern practice as indicated by architects and engineers of wide experience. It is hoped that adherence to these requirements will permit of the simplification of controller manufacture, improved service, economies in installation, and other advantages of standardized practice.

The specifications supplement the National Electric Code and deal particularly with the need for enclosing control apparatus, disconnecting means, overload protection, etc.

Changes in Black & Decker Personnel

Robert D. Black, branch manager for the Black & Decker Mfg. Company, in charge of the Philadelphia territory, will return to headquarters about the middle of November to take up his new duties as advertising manager for the company. Mr. Black succeeds Mr. Brogan as advertising manager, effective January 1, 1924, at which time Mr. Brogan will take up his new work in connection with G. W. Brogan, Incorporated, which concern will handle the advertising of the Black & Decker Mfg. Company. H. G. Smith, at present resident salesman for Pittsburgh and Western Pennsylvania, will succeed Mr. Black as branch manager in charge of the Philadelphia territory, including all of Pennsylvania, Delaware and New Jersey from Trenton south. E. D. Allmendinger, formerly working in the Detroit territory, has returned to headquarters at Towson, where he will take charge of the export business, a separate export department having now been formed to take care of this work, which was previously handled in connection with domestic business. M. A. Weidmayer, formerly working in Philadelphia and Eastern Pennsylvania, out of the Philadelphia office, has been promoted and will take up immediately his new selling duties in the Industrial Department. Mr. Weidmayer's new address will be 461 Eighth avenue, New York City. R. E. Mizener, who formerly worked in Ohio, out of the Cleveland branch office, has been promoted and will take up immediately his new selling duties in connection with the industrial department. His new address will be 461 Eighth avenue, New York City. T. C. Cornell has been employed as salesman to work in Ohio with headquarters at the branch office in Cleveland. Mr. Cornell succeeds Ray E. Mizener. Henry Fox, formerly located in the general sales department at Towson, succeeds Mr. Allmendinger as salesman in the Detroit territory and his new address will be General Motors Building, Detroit, Michigan.

Soo Line and C. & E. I. Insure Passengers

The Minneapolis, St. Paul & Sault Ste. Marie and the Chicago & Eastern Illinois have inaugurated the sale of travel accident insurance to passengers purchasing tickets over these lines. This will be designated as passenger coupon accident insurance which is available for both men and women and which is sold to cover short or long trips with a premium fixed at an amount equal to one per cent of the cost of the railroad ticket.

Santa Fe Contemplates Electrification

A survey of the hydro-electric possibilities of the Colorado river has been completed by the Atchison, Topeka & Santa Fe with a view to possible electrification of its transcontinental lines in the desert, according to a statement made by W. B. Storey, president of the system, before members of the Chamber of Commerce of Pasadena, Cal. No definite plans have been made.

Broad Street Station Restored

The Pennsylvania Railroad announced that with the discontinuance of summer time and the inauguration of the regular winter train schedules on Sunday, September 30, Broad Street Station, Philadelphia, put fully in use and the train service it enjoyed previous to the fire of June 11 will be restored. The work of rebuilding the train shed has reached a point where it is possible to run all trains in and out of the station. The time of short distance trains which was advanced in the spring to conform to local daylight-saving, will be run one hour later.

Filling a Long-Felt Want

One of the humble duties of the custodian of a large railway station nowadays consists in that portion of his floor-cleaning function which clears stone and concrete floors of the dabs of chewing gum which hundreds of people try, every day, to imbed in the floor in such a way that the offensive mass can never be got out; and one of the latest inventions in the railroad world is an electric motor, operating a 4-in. blade, by which this unpleasant job is accomplished in about one-fourth the time that has been possible under former conditions. That is to say, the one man operating the machine can, in a given time, perform work equivalent to that formerly done by four men. One of these motor-scrapers is in use at the Pennsylvania Station, New York City. It works with a motion similar to that of a tie-tamper. It is mounted on a two-wheel carriage, running on rubber tires, and is managed by

means of a long handle, similar to that of a vacuum carpet cleaner. It is made by the Electro-Magnetic Tool Company, 5 Great Jones street, New York.

C. N. R. Neebing Terminal in Service

The Canadian National's new terminal at Neebing, near West Fort William, Ont., has been placed in service. The terminal was built to expedite the handling of grain traffic, most of which goes via lake from this point eastward.

The Neebing yard is designed to handle 2,000 cars a day, classifying them for distribution to the elevators and vessels. Most of the cars will be put over the hump. There are eight receiving tracks with a capacity of 80 cars each; an eastbound classification yard with 20 tracks of a total capacity of 1,250 cars; a westbound departure yard of 13 tracks, each with a capacity of 80 cars, and repair tracks with a capacity of 108 cars.

The buildings and equipment include a 24-stall roundhouse; an 85-foot electrically operated turntable; a 300-ton coaling station; a 150,000-gallon steel water tank; a 1,000-gallon oil tank; an automatic electrically driven ash remover and loader as well as other modern mechanical features in and about the repair yards, engine houses and plant.

Obituary

Langdon Gibson, who up to two years ago was production manager of the General Electric Company, Schenectady Works, died September 5 at Criehaven, Maine, where he was spending the summer. Mr. Gibson was a noted explorer and brother of Charles Dana Gibson, well-known artist. He had been associated with the General Electric Company for 31 years and was well known throughout the industrial world. Mr. Gibson was a man of great activity and vigor, being one of the few members of the Stanton expedition successfully completing the expedition through the Grand Canyon of the Colorado river in 1889. He gained added fame through his accompanying Admiral Peary on his second northern expedition to explore and map the northern coast of Greenland.

Trade Publications

Johns-Pratt Company, Hartford, Conn., is distributing three illustrated booklets describing respectively the Noark universal service switches, service boxes, and Vulcabeston pump valves.

Electric Storage Battery Company, Philadelphia, Pa., has recently issued the third edition of its illustrated catalogue on Exide batteries for railway automatic signals, interlocking plants and automatic train control operation.

The Copper Clad Steel Company, New York, N. Y., has recently issued a 4-page folder on engineering data and wire tables for copper weld wire. The folder is 8 in. by 11 in. and is perforated for the purpose of inserting in a loose-leaf binder.

Electric Headlights.—A 12-page booklet entitled, "Electric Headlights," has recently been issued by the Sunbeam Electric Manufacturing Company, Evansville, Ind., which illustrates and describes the locomotive headlight, industrial headlight, and floodlights manufactured by that company. The booklet also describes the focusing device used in conjunction with the air-tight, silver-plated, metal reflectors.

The Warner Elevator Manufacturing Company, Cincinnati, Ohio, is distributing a four-page folder entitled, "The Latest Developments in Electric Elevators," in which is presented a 2-speed, 2-capacity, alternating current motor for elevator service.

Johns-Pratt Company, Hartford, Conn., is distributing an illustrated folder entitled, "The Primary Responsibility of the Central Station is Safety." The folder emphasizes the importance of main entrance and meter service installations that are absolutely safe.

Mitchell-Rand Manufacturing Company, New York, N. Y., has just issued a 160-page, illustrated, paper-bound catalogue listing and describing various kinds of insulating material. The title of the book is "Everything in Insulation" and the list includes electrical insulation of all kinds, such as asbestos, mica, tapes, clothes, rubber, waxes, etc. Various compounds and varnishes are also included. In the back part of the book are a number of useful conversion tables.

Insulators and Line Material.—The Westinghouse Electric and Manufacturing Company has issued a new catalogue covering line material and porcelain insulators. The catalogue is supplementary to the company's large supply catalogue and has been issued for the convenience of purchasers of these two allied lines of materials. It is a 200-page publication of convenient size, is fully illustrated, and contains a complete description of all the company's line material and porcelain insulators.

Sangamo Electric Company, Springfield, Ill., is distributing its bulletin No. 62 entitled "Locomotive Type Ampere-Hour Meter." The bulletin is 8 in. by 10 in. and contains 24 in. devoted to the illustration and description of "Locomotive Type" meter. Photographs, line drawings and wiring diagrams are given as well as a complete list of all the individual parts from which they may be ordered. The portion of the pamphlet tells of the care and maintenance which these meters should receive.

The General Electric Company, Schenectady, N. Y., has recently issued its bulletin No. 43,976 on charging equipment for vehicle motive power batteries. There are two classes of apparatus described in the bulletin; first individual battery charging motor generator sets with switchboard for Edison or lead batteries, for non-automatic or automatic operation. Second, motor generator sets with switchboards for charging two or more Edison or lead batteries, for non-automatic or automatic operation.

The Ohio Brass Company, Mansfield, Ohio, has just issued its catalogue No. 19 covering the years 1924 and 1925. The book contains 770 pages, 6 in. by 9 in., bound in cloth. It is well illustrated with many photographs and line drawings showing the great variety of insulators, pins and other line material which the company manufactures. The various sections of the catalogue may be quickly located by means of a convenient thumb index. Many useful tables are included in the back portion of the book.

Railway Electrical Engineer

Volume 14 NOVEMBER, 1923 No. 11

Radio on the Railroads

Radio telephony and broadcasting as it has become familiar to almost every one is a matter of but a few short. years. It was only in the fall and winter of 1921 that it began to spread throughout the country like wildfire and since that time the radio business has assumed tremendous proportions. Receiving outfits constructed two years ago have been far surpassed by much more sensitive and satisfactory sets which have made it possible to use such equipment under conditions hitherto thought to be well nigh impossible. It is true experiments between moving trains and stationary points have been made in the past but it is only quite recently that results of such experiments have become at all satisfactory. Moreover, in view of the fact that such tremendous strides have been made in so short a time in the radio art, it is altogether probable that present achievement may be very greatly surpassed within the next few years.

Regarding the application of radio to railroad trains there are two phases which may be considered, first, the entertainment phase, which is primarily for the diversion of the passengers, and second, the utilitarian phase for the purpose of communication to and from a train at any time and at any place on the line, or between the head and rear ends of long freight trains.

The present indications are that so far as a mere entertainment feature is concerned, the application of radio on trains is not destined to become an important factor. The general public have become more or less satiated with broadcasting programs during the past two years so that aside from mere curiosity it is extremely doubtful of any radio installation made for the sole purpose of entertainment can hope for lasting favor. It is possible on long trips that the use of headphones might prove to be desirable but even this is open to question, while the use of loud speakers is almost certain of adverse criticism from some passengers who would consider them an annoyance rather than a source of entertainment.

The second phase which has for its purpose communication to and from trains in transit bids fair to become increasingly useful as inevitable improvements in radio development take place. There is little question but that in certain localities it would be desirable to be in communication with a moving train at any time and it becomes merely a matter of simplicity of equipment, low cost and reliability. These requisites will all be successfully met in time and there is little doubt but that this type of communication will eventually become common practice, where desirable.

In the meantime the progress that has been made in radio as applied to moving trains is most interestingly set forth in the report of the A. R. E. E. committee on this subject which appears in this issue.

The Fourteenth Annual A. R. E. E. Convention

The issue of the *Railway Electrical Engineer* now in your hands contains all of the reports of the various committees of the Association of Railway Electrical Engineers. These reports will be presented at the Fourteenth Annual Convention of the Association which will be held at the Hotel La Salle, Chicago, November 6 to 9 inclusive. On account of the large number of the reports and of the length of some of them, it was decided to omit the regular departments of the *Railway Electrical Engineer* with the exception of the general news section. Inasmuch as the material contained in the reports covers practically every activity of electrical men in the steam railroad field the reader who is not able to attend the convention is assured of finding much information of interest.

The field for electrical applications in steam railroad operation has grown rapidly and there is every indication that it will continue to grow in the future as it has in the past. There are continually new uses being made of electrical energy and in practically every case the new application is marked by lower expense and increased efficiency. If one would keep pace with this constantly expanding field, it is absolutely necessary to be in touch with the activities of the electrical men at all times. The present issue of the *Railway Electrical Engineer* tells in the form of committee reports just what is taking place on the various roads. It is brimful of useful information. Don't lay it carelessly aside but preserve it as a valuable reference, which it really is.

Self-Propelled Rail Cars

The report on self-propelled rail cars presented to the Association of Railway Electrical Engineers this year, published elsewhere in this issue, is an unusually able and comprehensive report. No elaborate data are included, but the substance of the report is fundamental in character and should constitute a good foundation on which to base continued activity of the committee.

It is significant to note one paragraph in the report which states that the ordinary terminal maintenance forces are rarely to be relied on for satisfactory service to self-propelled cars. The report suggests that some individual who is of the right temperament should be made respon-

sible for the care and maintenance of the cars and his suggestions should receive careful attention.

A report on self-propelled rail cars was also presented this year at the annual meeting of the American Electric Railway Association. An abstract of this report was published in the October issue of the *Railway Electrical Engineer*. One of those to discuss this report was C. R. Harte, construction engineer of the Connecticut Company. The Connecticut Company is a railway company which operates a fleet of highway buses. Mr. Harte said in effect: There is need for developing a machine which, figuratively can be repaired with a sledge hammer. The internal combustion engine is a complicated piece of mechanism which requires fine mechanical ability to maintain it successfully. If it is going to be a popular method of transportation, it must be brought more into line with what our electric railway motors are today, namely, a machine which can be maintained in good condition by men with only fair mechanical ability.

The bus and the rail motor car are in a state of development and the manufacturers are doing their utmost to make them conform with all that the operators want. It would seem, therefore, that the most necessary work to be done on the part of the railroad men is to make the buses conform to all railroad requirements. It is necessary for example to learn how to make the cars operate all types of signals satisfactorily and there is much to do in developing proper facilities for the maintenance of the cars.

The Development of Electric Welding

The position of the electrical man on the railroad with reference to welding is pointed out clearly in the report of the committee on electric welding presented to the Association of Railway Electrical Engineers and published elsewhere in this issue. The report states that while the actual application of welding does not generally come under the jurisdiction of the electrical men, they have in the past done much to point out the advantages of welding.

The electrical men have also done much to develop the welding machines and as long as electric welding is done there will be a demand for electrical men in this work. The matter of designing the machines is now, as it should be, practically all in the hands of the manufacturers. The railroads have only to show the need for a certain kind of equipment in order to have that equipment developed for them.

Maintaining and serving the machines and the welders, however, is something which will probably always be left in the hands of the electrical men. The use of electric welding is increasing rapidly and this means the installation of new machines, power circuits, safety devices, etc. Users are learning what is necessary to the making of a good weld and are becoming more exacting in their requirements. Improperly controlled apparatus or poor ground connections on the welding circuit may be the causes of poor quality welds. Welding generators must have certain electrical characteristics and when they are repaired these characteristics must not be changed. These are essentials which will probably always be turned over to the electrical man and the man who is familiar with these requirements is in a position to be of real service to his road and to the advancement of the art of welding. The success of electric arc welding as a process is dependent upon uniform results and uniform results are in turn dependent upon skillful operators and upon machinery that will always function in the way it is expected to.

The Function of The Interchange

There is every reason to believe that most of the readers of the *Railway Electrical Engineer* read with interest the department known as "The Interchange." Many have written to us and told us so. The primary object of this department is as its name indicates, to bring about an interchange of ideas between the electrical men in the steam railroad field, but this can only be accomplished successfully through the cooperation of the readers interested in this section of the paper. If you have developed some practical stunt or method of performing some operation, write a description of it and send it to the editor. Any device which has proved to be a time and labor saver to one man is sure to be of interest to others and it will always be possible to find a place for it in the *Railway Electrical Engineer*. Not only will you have the gratification of seeing your device published but you will receive compensation for the time required in preparing the description. Let the other fellows know about the things you have found useful in the same way you profit by their ideas.

New Books

Fundamentals of Welding—Gas, Arc and Thermit. By James W. Owens, welding aide, U. S. Navy Yard, Norfolk, Va. 672 pages, 279 illustrations. Published by the Penton Company, Cleveland, Ohio. Price $10.

The book has been prepared to be a complete course of instruction in welding and it deals with gas, arc, thermit and resistance welding. It contains information telling what kind of welding is best and cheapest, according to the material to be welded, the characteristics desired in the weld, the strength required, the size of the weld, etc.—how to prepare different kinds of joints in various kinds of materials and describes many kinds of welding apparatus and material. It explains the metallurgy and metallography of welds, tells how to inspect and test welds and contains standard welding specifications. There are 25 chapters under the following titles: Classification and Nomenclature; Preparation and Finish; The Gas Weld; The Arc Weld; Technic of the Arc Weld; The Thermit Weld; Gas and Arc Cutting; Metallography of the Weld; Residual Stresses; Speed and Cost of Welding and Cutting; Choice of Methods; Design; Inspection and Tests; Production and Distribution of Oxygen, Hydrogen and Acetylene; Arc Welding Generators and Transformers; Welding and Cutting Machines; Welding Rods, Electrodes and Fluxes; Protectors and Safety Precautions; Organization, Shop and School Layouts; Training; A practical Gas Welding and Cutting Course; A Practical Arc Welding Course; Standard Specifications; Practical Applications; Summary and Conclusions. The author has been actively engaged in all kinds of welding for a number of years and in the spring of 1918 was engaged by the Navy Department as welding expert. Since then he has organized and operated the first welding shop in the Navy in which all kinds of welding were employed, has built the two largest welded structures ever erected and has conducted welding research costing over $150,000.

Illinois Central Railroad, Chicago

Association of Railway Electrical Engineers Fourteenth Annual Convention

November 6th to 9th, Chicago

CONVENTION PROGRAM

Meeting in Red Room, 19th Floor, Hotel La Salle,
Exhibits, Grand Ball Room, 19th Floor

TUESDAY, NOVEMBER 6TH

Session 10:00 A. M. to 1:00 P. M.

Address of President.
Report of Secretary-Treasurer.
Report of Auditing Committee.
Unfinished Business.
New Business.
Election of Officers.
Committee on Data and Information. (pg. 331).

WEDNESDAY, NOVEMBER 7TH

Session 9:30 A. M. to 1:30 P. M.

Committee on Power Trucks and Tractors. (pg. 369).
Committee on Heavy Electric Traction. (pg. 339).
Sponsor Committee on Insulated Wires and Cables. (of "American Engineering Standards Committee") (pg. 338).
Committee on Illumination. (pg. 361).

THURSDAY, NOVEMBER 8TH

Session 9:30 A. M. to 1:30 P. M.

Committee on Motor Specifications. (pg. 329).
Committee on Electric Welding. (pg. 367).
Committee on Self-Propelled Cars. (pg. 333).
Paper by Charles Dillon, Asst. to Chairman, Western Railway Presidents Committee on Public Relations. Subject: "What Is Happening to Transportation?"

FRIDAY, NOVEMBER 9TH

Session 9:30 A. M. to 12:00 Noon.

Committee on Train Lighting Equipment and Practice. (p. 328)
Committee on Radio Apparatus on Moving Trains. (pg. 340).
Committee on Electric Headlights. (pg. 354).
Committee on Automatic Train Control. (pg. 330).
Afternoons will be devoted to Inspection and Study of Electrical Appliances in Exhibit Room.

Registration

Please register and secure badges at Secretary's Desk. Located in hall on Nineteenth Floor.

Theatre and Dinner Tickets should be reserved at time of registering.

Entertainment

Exhibits are located in Ball Room on the Nineteenth Floor and will be open from Monday evening until Friday noon.

Tuesday Evening, November 6th—Informal Reception and Dancing Party, Nineteenth Floor, Hotel La Salle Red Room, 8:30 P. M. Refreshments will be served. Admission by badges.

Wednesday Afternoon, November 7th—Ladies' Theatre Party (Geo. M. Cohan's Grand Theatre, "The Rise of Rosie O'Reilly"). Secure tickets at Secretary's Desk, from Tuesday noon up to Wednesday noon. Tickets should be reserved at time of registering.

Wednesday Evening, November 7th—Informal Dance, Nineteenth Floor, Hotel La Salle Red Room, 8:30 P. M. Admission by badges.

Thursday Evening, November 8th—Informal Dance, Red Room, Nineteenth Floor, Hotel La Salle, 8:30 P. M. Admission by badges.

Friday Evening, November 9th—Informal Dinner-Dance, Nineteenth Floor, Hotel La Salle Ball Room, 7 P. M. Secure tickets at Secretary's Desk after Wednesday noon.

Report of Committee on Train Lighting Equipment and Practice

Reduction in Number of Pulley Bushings Recommended. Wide Face Pulley Most Suitable Where Sharp Curves are Encountered

Committee:—

L. S. Billau, Chairman, Assistant Electrical Engineer, Baltimore & Ohio; E. Wanamaker, Electrical Engineer, Chicago, Rock Island & Pacific Railroad; E. W. Jansen, Electrical Engineer, Illinois Central Railroad; D. J. Cartwright, Supervisor Car Lighting, Lehigh Valley Railroad; F. J. Hill, Chief electrician, Car Department, Michigan Central Railroad; J. L. Minick, Assistant Engineer, Pennsylvania System.

To the Members:

Conditions during the past year have been such as to render it impossible for your committee to undertake work of any magnitude and it has, therefore, confined its activities to a study of the subject assigned to it by the Committee on Subjects and to include a brief review of some of the recent developments in axle generator belt drives.

Axle Generator Pulley Bushings

Your committee was directed to investigate the subject of axle pulley bushings with the view of determining the minimum number of sizes required to take care of the axle pulley mountings in general use and to establish the essential dimensions for these bushings. The only features of the bushing that have heretofore been standardized by the Association are:

"If a bushing be used, it shall preferably be secured to the axle independent of the pulley and have an external diameter throughout its length of 7½ inches and be not less than 8½ inches long."

This leaves to the user the determination of the actual length of the bushing and its internal diameters, the latter being dependent upon the size of axle and position on the axle at which it is used.

The corrugated steel type of split bushing is today most widely used for this purpose. Due to the lack of established dimensions for these bushings an investigation has developed that a very large number of sizes are in use. For the 5 x 9 axle alone over twelve sizes of bushings have been found which are used to a considerable extent, many of them differing by only a very small fraction of an inch in the internal diameters. The disadvantage of so large a variety of sizes of bushings both from the point of view of the railroads and the manufacturer is obvious.

As a result of a study of this subject it has been found that two sizes of bushings for each size of axle will take care of practically all pulley positions in general use today. In this study consideration has been given only to bushings for application to the taper section of the axles. The internal diameters shown for the bushings are based on the assumption that the axles are turned to the actual dimensions given for standard A. R. A. axles. The lengths for the bushings have been selected to permit using the same bushing either with or without bushing clamp. A long bushing is also desirable as it provides for a greater range for shifting the bushing along the axle to correct for variations in the actual diameters of the axles along the section where the bushing is applied. Different lengths for the two bushings for the same size axle have been selected to facilitate ready identification due to the small differences in the internal diameters for these two pulley bushings.

The proposed dimensions for axle pulley bushings for the sizes of A. R. A. axles shown and the proposed designations for such bushings are given in Table I.

TABLE I

Axle Pulley Bushing Dimensions

A. R. A. Size Axle In.	Bushing Designation	Location of Center Line of Bushing from Center Line of Axle In.	Bushing Dimensions: Length In.	Diameters: Inside: Large End. In.	Diameters: Inside: Small End. In.	Diameters: Outside In.
4¼x8	B–1	13	13	5 11/32	4 29/32	7½
	B–2	7½	12	5⅛	4¾	7½
5 x9	C–1	13	13	6 1/16	5 9/16	7½
	C–2	7½	12	5⅞	5⅜	7½
5½x10	D–1	13	13	6⅝	6 1/32	7½
	D–2	9	12	6 13/32	5⅞	7½
6 x11	E–1	12	13	7 3/32	6 17/32	7½
	E–2	9	12	6 31/32	6 7/16	7½

With the type of axle pulley in general use having a hub 6¼ inches long and using a bushing without clamps the range of pulley locations possible for the above bushings when latter are placed on the axle at locations designated in Table I is shown in Table II.

TABLE II

Range of Pulley Locations

Bushing Designation	Location of Center Line of Pulley from Center Line of Axle: Max.	Min.
B–1	16⅜	9⅜
B–2	10⅜	4⅝
C–1	16⅜	9⅝
C–2	10⅜	4⅝
D–1	16⅜	9⅝
D–2	11⅞	6⅛
E–1	15⅜	8⅝
E–2	11⅞	6⅛

For axle generator drives where it is desired to have the center line of the belt coincide with the center line of the car it is necessary either to use wide face axle pulleys having two separate hubs or else employing bushings of special design if single hub pulleys are used.

Axle Generator Belt Drive

In view of the importance of the subject of the drive for axle generators and the fact experiments or any other developments that offer promise of reducing the cost of maintenance of the drive or increasing its reliability are of great interest to all car lighting engineers, your committee has been directed to include as a regular part of its report each year a review of such developments. During the past two years there has been developed the so-called "wide face" type of axle pulley which is clamped to the car axle at two points by separate hubs. Thus far two general designs have been brought out.

One design is known as the barrel type of pulley and as first developed was 18½ inches in diameter, 33½ inches over-all, having 1 inch flange. Due to the difficulty that was encountered in service in applying and removing the pulley the design was shortened to 28½ inches and other improvements made to overcome this trouble. This design of pulley has been used entirely with the free speed type of generator and with the belt located along the center line of the car. There are over fifteen hundred of these pulleys in service.

The other design is 18 inches in diameter, with 24 inch

straight face and 2 inch flaring flange. This pulley has so far been used only with the controlled speed type of axle generator, the belt being located approximately 5 inches from the center line of the car. Approximately one hundred of these pulleys are in service on one railroad and fifty on another.

These two types have not as yet been in service under sufficiently diversified operating conditions and length of time to permit accumulating enough data on which to base reliable comparison of the relative merits of the wide face pulley with respect to the standard type of axle pulley. Both types of wide face pulley have demonstrated that they will practically eliminate the throwing off of belts with body hung suspensions where cars are operated over extremely short radius curves, such as exist in some of the older railroad passenger car yards, express stations, etc.

The company operating the barrel type of pulley reports that an average of over 50 per cent increase in belt life has been secured with the wide face pulley, center drive suspension compared with the same type of suspension using standard 10 inch face pulley with belt 10½ inches from center line of the car. These figures, however, do not reflect a true picture of the relative performance. Cars operating in service where they have no serious curves to contend with show little, if any, difference in belt life performance. The conclusion was therefore reached that this average increase for the cars equipped with the wide face pulley was accomplished through the large reduction of belt losses on the comparatively small percentage of cars operating regularly through the four or five yards having extremely short curves.

Another railroad operating the 24 inch face pulley with the controlled speed type of generator reports that cars operating principally in main line service show but approximately 12 per cent average increase in belt life over cars equipped with the same type of generator using the 10 inch face pulley and belt located 10 inches from the center line of the car, while express cars which run into a number of yards and stations having short radius curves show approximately 100 per cent increase in belt life. The necessity for having an electrician regularly assigned to inspect all cars coming out of these yards and replace belts that have run off of the pulleys with the standard type of suspension, has been eliminated.

Data thus far secured seems to indicate that the wider face type of pulley may be of considerable benefit to railroads having abnormal conditions of this kind to contend with but that it might not be of any particular value to others.

The report of this committee last year contained a description of a belt drive using a universal axle pulley. This test equipment has now been in service since May 17, 1922, having made a total mileage of over 227,000 miles. The original belt (5″ 4-ply) is still in service and during this period has been shortened four times. A special flexible type of belt fastener is used which was specially developed for use with this drive. The report indicated that the pulley, belt and fastener are still in good condition.

Recommendations

Your committee would recommend the adoption as recommended practice of the dimensions of axle pulley bushings as contained in Table I of its report. For the railroads to secure the benefits of the reduction in number of sizes of axle pulley bushings as now manufactured it will be necessary for them to use bushings of the proposed standard sizes. Your committee would, therefore, urge that each railroad look into this matter and where not using a bushing that conforms to one of the proposed standard sizes ascertain if standard sizes could not be adopted to advantage.

Respectfully submitted,

COMMITTEE ON TRAIN LIGHTING EQUIPMENT AND PRACTICE.

Report of Committee on Motor Specifications

Specifications Drawn to Cover Short Time Duty Motors Such as for Turntables, Bending Rolls, Cranes, Etc.

Committee:—

E. Wanamaker, Chairman, Electrical Engineer, Chicago, Rock Island & Pacific Railway; E. W. Jansen, Electrical Engineer, Illinois Central Railroad; J. E. Gardner, Electrical Engineer, Chicago, Burlington & Quincy Railroad; E. Marshall, Electrical Engineer, Great Northern Railway; G. T. Goddard, General Electrical Foreman, Illinois Central Railroad.

TO THE MEMBERS:

The Motor Specification Committee for 1922 drafted a specification covering continuous duty, a.c. and d.c. open type motors from 1 hp., 1,800 r.p.m. to 75 hp., 900 r.p.m. inclusive. This year we have so revised the 1922 specifications as to include specifications covering motors required for operation on a cycle of duty which repeats itself more or less regularly, known in these specifications as the "short time duty motors," and your Committee believes that specifications as now revised cover practically all motors used in general railway service, not including motive power equipments, nor any motors required for some particularly special service.

The revised specification is herewith attached to and made a part of this report.

A. R. E. E. Motor Specifications

Intent and Scope

It is the intent and lies within the scope of these specifications to guide the purchaser in the selection of and the manufacturer in the furnishing of electric motors for steam railway service. These are two primary factors which make it desirable to formulate such a specification.

First. The fact that motors in steam railway service are operated and maintained under conditions peculiar to that service.

Second. The fact that motors as offered to the railroads by the various motor manufacturers differ widely in quality and design for the same sized motor as identified by horse power and speed.

Uninterrupted service is of first importance. Because of wide distribution of motors, the commercially practicable impossibility of accurately predicting and maintaining the exact load requirements, and the lack of com-

petent supervision in isolated localities, it is essential that motors supplied to the railroads shall be liberal in mechanical and electrical design.

When purchasing short time duty motors required for operation in a cycle of duty which repeats itself more or less regularly, the purchaser should give due consideration to the percentage of time that the motor will actually be in service and the percentage of rated hp. loading that will be imposed upon the motor. For example:

Motors used to operate tail stocks are used infrequently and motors having a 15-minute rating may well be used for such and similar classes of service, while in other classes of service requiring short time duty motors, a longer time rating should be selected where the periods of operation are longer or the load heavier. In general, short time duty motors are in common service on turntables, bending rolls, transfer tables, cranes, etc.

With these points in view, motors furnished under these specifications shall fully meet the following requirements:

Specifications for A. C. and D. C. Motors from 1 HP. 1,800 R.P.M. to 75 H.P. 900 R.P.M. Inclusive

(*A*) *Continuous Duty Open Type Motors:*

An observable temperature of 95 degrees C. shall not be exceeded when the motor is subjected to a 25 per cent overload for two hours immediately following continuous operation at full load with a room temperature of 40 degrees C.

(*B*) *Short Time Duty Motors:*

(a) 50 degrees C. rise in temperature in 60 minutes shall not be exceeded when operated at rated hp. as stamped on motor name plate.

(b) 50 degrees C. rise in temperature in 30 minutes shall not be exceeded when operated at rated hp. as stamped on motor name plate.

(c) 50 degrees C. rise in temperature in 15 minutes shall not be exceeded when operated at rated hp. as stamped on motor name plate.

(d) Where enclosed motors are specified, time ratings will be the same as under (a), (b), and (c) above, but temperature ratings shall not exceed 55 degrees C.

(e) Where motors having Class "B" (non-combustible) insulation are used, time ratings will be the same as under (a), (b), and (c) above and temperature rise shall not exceed 70 degrees C. for open motors, and 75 degrees C. for enclosed type motors.

(f) Short time duty motor name plates shall plainly state time and temperature ratings as well as rated hp.

(*C*) *General—All Motors:*

1. COMMUTATION:

Direct current motors shall operate with full field from 0 to 150 per cent load without any sparking.

2. BEARINGS:

(a) The bearings shall be of such size and capacity as to insure constant operation with freedom from heating, when the motor is subjected to conditions equalling or being comparable to an imposed overload of 250 per cent.

(b) When babbitted bearings are furnished, the shells shall be of ample thickness to permit rebabbitting without warping.

3. SHAFTS:

Shafts shall be so designed as to be free from excessive spring or vibration when operating under the overload conditions hereinbefore specified, when the driving pinion or pulley is applied in conformance with approved engineering practice.

4. BEARINGS AND HOUSINGS:

The bearings and housings shall be so constructed as to entirely prevent the escape of lubricant.

5. Temperature ratings included in this specification refer to insulated winding only.

When requested, manufacturers furnishing motors under these specifications will supply data sheets, including power factor, efficiency and torque characteristics.

All electrical tests shall be conducted in conformance with the rules and requirements of the American Institute of Electrical Engineers.

Respectfully submitted,
COMMITTEE ON MOTOR SPECIFICATIONS.

Report of Committee on Automatic Train Control

Maintenance of Equipment by Both Signal and Mechanical Departments Under Authoritative Supervision Apparently Desirable

Committee:—

E. Wanamaker, chairman, electrical engineer, Chicago, Rock Island & Pacific Railway; Frank E. Starkweather, electrical engineer, Pere Marquette Railroad; Chas. G. Winslow, assistant electrical engineer, Michigan Central Railroad; G. W. Bebout, electrical engineer, Chesapeake & Ohio Railroad.

TO THE MEMBERS:

Your Committee begs to submit herewith the following report for the 1923 Convention.

Three meetings of this Committee have been held with all members present.

In view of the comparatively recent development of automatic train control systems, your Committee deems it advisable to deal with the subject in its entirety, but in a general manner.

All of the various concerns who have developed automatic train control systems have complied with the request of the Committee to submit data and information having to do with the design and their proposed method of operation of their individual types and classes. This data and information has been duly filed, but your Committee does not feel that it is desirable to have all this data compiled and made a part of this report since it is possible for any one desiring detailed information on any particular type, or as manufactured by any individual manufacturer, to secure the desired detailed information from the concern marketing the equipment; also the *Railway Electrical Engineer* and *Railway Signaling* publish a list of installations as made by the various manufacturers on the different railroads from time to time as occasion justifies. However, the following list indicates those manufacturers who have contributed such data and information to this Committee.

Regan Safety Devices Co., Inc., 1051 Peoples' Gas Bldg., Chicago.

General Railway Signal Co., Rochester, N. Y.
Union Switch & Signal Co, Swissvale, Pa.
Sprague Safety Control & Signal Corp., 421 Canal St., New York.
The National Safety Appliance Co., Peoples' Gas Bldg., Chicago.
Miller Train Control, Danville, Ill.
Beggs Automatic Stop & Speed Control Co., Vincennes, Indiana.
American Train Control Corp., Baltimore, Md.
Buell Control Co., Washington, D. C.
International Signal Co., New York, N. Y.
Nevens Wallace Train Control Co., Waltham, Mass.
Simmon Automatic Ry. Signal Co., Eden, N. Y.
Simplex Train Control Co., Rochester, N. Y.
Train Control Appliance Co., El Paso, Texas.
Warthen Train Control Corp., Washington, D. C.

There are in process of installation today two general types of automatic train control systems—electrical and mechanical. The majority of automatic train control systems are of the electrical type which includes intermittent contact type, the inductive (which may be either intermittent or continuous) and the wireless. The mechanical type is either of the ramp or trip. All of these systems are designed to convey a signal from the roadside indicating the condition of the block. It is also converted or transformed into mechanical power such as will cause the desired functioning of the brake system.

It is the chief intent of the automatic train control system to secure safer train operation and expedite train movements. Bearing this intent in mind the railway companies installing automatic train control systems have endeavored to install so as to meet their local or individual conditions and at the same time meet all the requirements of the Interstate Commerce Commission.

Locomotives equipped with electrical type of automatic train control may have installed in addition to the brake operating mechanism a visible or audible (or both) form of cab signal, giving an indication of the condition of the block.

The air brake functioning apparatus is generally so designed as to provide an automatic application of the air to the locomotive in such a way as to reduce the speed to that required by the roadside signal indication.

As a rule provision is also made for permissive operation of the train by re-setting the brake apparatus in such a way that a stop signal may be passed at slow speed, but must be recognized by the engineer. The permissive speeds referred to are pre-determined and cannot be exceeded by the enginemen. This feature, in addition to permitting more flexible train operation, is very advantageous in case a train is stopped while in a tunnel.

Automatic train control systems, in addition to applying automatic brake to engines and train equipment, also provide a double check on indications now being given through automatic signal territory, such as defective relays, open switches and block not being occupied.

The progress that has been made so far in automatic train control indicates that the method or system for maintaining and operating train control equipment is equally as important as it is to secure an efficient installation.

The committee does not feel that it would be advisable to build up a new organization to handle automatic train control equipment. It may, however, be highly desirable to have someone sufficiently conversant with signaling, locomotive equipment and train operation, invested with sufficient authority to enforce the necessary co-operation of all concerned in the maintenance and operation of train control equipment.

It is felt from the experience so far gained that the signal and engineering departments are best fitted to maintain the roadside equipment, while the mechanical department is best fitted to maintain that part of the apparatus that is installed upon the locomotive.

Each department concerned should have men who are sufficiently conversant with the equipment under their supervision to insure the proper maintenance of the equipment, and there should be an engineer or supervisor who will have authority to compell co-ordination between these departments.

It is highly desirable that the necessary shop facilities be furnished those held responsible for the maintenance and operation of train control equipment to take care of regular repairs.

In view of the rapid expansion of automatic train control the Committee feels their work should be carried on for at least another year.

Respectfully submitted,

Committee on Automatic Train Control.

Report of Committee on Data and Information

Returns From the Various Roads Show Steady Increase in the Use of Electrical Equipment

Committee:—

E. A. Lundy, chairman, *Railway Electrical Engineer;* J. A. Andreucetti, assistant electrical engineer C. & N. W. R. R.

To the Members:

In the preparation of this report, it was thought that it would be of interest to show not only the apparatus in service this year, but to show also the electrical development over a period of years and to give some idea regarding future possibilities.

A study of the charts accompanying this report will show conclusively that electrical applications are gaining rapidly and that the uses to which electrical energy is being put on steam roads are increasing almost daily.

This year we have reports from 75 railroads representing 70 per cent of the mileage in the United States and Canada. To show more readily the extent of electrical developments and to make individual comparisons, several small charts shown in connection with this report have been tabulated from the master chart and data contained in previous A. R. E. E. reports. In the preparation of these charts the railroads were tabulated according to their respective mileages in order that comparisons may be made more readily.

A careful analysis of the charts will show that even though electrical applications are increasing rapidly, the field has hardly been scratched. The activity in electrical work on the railroads has been much greater, so far this year, than at any time during the past twenty years. This speeding up in electrical work naturally follows the launching of the $1,500,000,000 railway program last spring, and without question the purchases of electrical devices

and materials will greatly exceed the annual $40,000,000 mark reached in recent years.

The following paragraphs suggest how electric power can be used in furthering more efficient and economical operation of railway facilities.

Motor drive for shop tools, cranes, hoists, turntables,

TABLE 1

Railroad	MOTORS IN SERVICE Mileage	Year 1916	1922	1923	MOTOR APPLICATIONS Pumping Stations	Coaling Stations	Turntables	Machine Tools
P. & L. E.	225	*...	451	458	15	12	8	408
W. M.	702	133	—	400	6	14	6	178
D. & H.	873	299	364	389	10	14	15	118
D. L. & W.	981	895	1,128	1,225	2	13	23	531
C. & A.	1,132	243	—	307	10	12	7	160
N. Y. C., St. L.	1,247	—	—	94	3	—	14	32
L. V.	1,442	—	454	498	5	10	12	214
C. of G.	1,924	46	—	423	7	6	4	400
N. Y., N. H. & H. Sys.	2,183	—	430	515	19	16	16	410
P. M.	2,213	—	206	276	22	12	7	126
C. C. C. & St. L.	2,416	436	694	706	37	17	19	623
Erie	2,447	—	—	814	11	8	20	206
Wabash	2,473	—	405	—	7	8	8	413
St. L. & S. F.	4,769	139	403	412	29	5	8	362
L. & N.	5,039	342	432	451	6	12	9	—
B. & O.	5,212	731	1,748	1,850	—	—	42	—
I. C. Sys.	6,180	642	1,072	1,655	59	31	39	1,364
N. P.	6,656	—	761	837	22	30	27	—
S. P.	7,117	684	1,288	1,333	96	1	12	1,007
M. P.	7,343	—	356	397	13	3	8	370
C. R. I & P.	8,123	336	628	689	—	—	25	210
G. N.	8,266	540	720	1,088	25	16	18	295
C. & N. W.	8,402	775	1,418	1,451	66	36	27	350
A. T. & S. F.	8,966	398	—	1,481	142	13	30	510
C. B. & Q.	9,393	512	—	1,297	55	33	15	749
U. P. Sys.	9,483	721	1,972	2,228	65	73	37	1,653
C. M. & St. P.	10,261	457	676	681	53	43	37	314
Penna.	10,531	4,032	7,168	—	—	—	—	—
Can. Nat.	21,923	—	—	6,352	41	58	10	1,231

* Note: A dash (—), indicates that either no information was available or that such applications were not in service.

pumps, coaling stations, etc., will increase production with a minimum of operating expense. Table 1 shows that progress has been made with these applications, and table 2 lists the steam railroad facilities in the United States and

TABLE 2

STEAM RAILROAD FACILITIES IN THE UNITED STATES

No. of	Approximately
Steam railways	1,100
Miles of main line	251,000
Passenger stations	50,000
Pumping	14,000
Coaling	4,500
Car shops	568
Locomotive shops	403
Round houses	3,271
Power houses	1,500
Passenger cars	56,290
Road locomotives	68,590

indicates where electrical applications can be used to advantage. Table 3 shows the distribution number and size of the motor used in a typical general shop.

TABLE 3

MOTORS IN ONE TYPICAL GENERAL SHOP

	D C Motors								A C Motors						
Horsepower	50	40	35	30	25	20	15	10 or less	220	50	35	25	20	15	10 or less
Locomotive shop	3	1	1	2	—	1	1	11	—	1	—	2	1	8	21
Boiler shop	—	—	—	—	—	—	—	—	—	—	1	1	2	—	15
Gen. blacksmith shop	—	—	—	—	—	—	—	—	1	—	—	—	—	1	2
Car machine shop	1	—	—	—	—	—	1	2	—	—	—	—	—	—	4
Car blacksmith shop	—	—	—	—	—	—	—	—	—	—	—	2	—	1	1
Planing mill	—	—	—	—	—	—	—	—	—	2	1	1	2	6	20
Cabinet shop	—	—	—	—	—	—	—	—	—	—	—	—	1	—	8
Total	4	1	1	2	—	1	2	13	1	3	2	6	6	16	71

Total motors, 129. Total horsepower, 2,000.

Proper illumination of stations, shops, terminals and yards will be a big step in the right direction for more efficient, safe and economical operation.

The electric arc for welding and building up worn parts will redeem thousands of dollars from the scrap pile. Table 4 gives an interesting picture of electric arc welding. This important end of electrical work apparently is beginning to get the consideration it deserves.

Work in freight and passenger terminals can be speeded

TABLE 4

ELECTRIC WELDERS IN SERVICE

Railroad	Mileage	1916	1918	1922	1923
W. M.	702	1	—	—	22
G. T. W. L.	—	*—	—	10	19
D. L. & W.	981	4	5	9	15
C. & A.	1,052	2	—	—	4
N. C. & St. L.	1,247	1	5	—	8
L. V.	1,449	2	—	10	12
C. G. W.	1,496	2	—	2	3
M. K. & T.	1,671	—	—	2	8
C. of G.	1,924	—	—	—	1
T. & P.	1,953	1	1	8	9
N. Y., N. H. & H. Sys.	2,183	2	2	13	19
N. & W.	2,238	—	15	31	—
P. M.	2,239	—	—	3	5
Erie	2,309	—	30	—	55
O. S. L.	2,360	—	1	2	4
C. C. C. & St. L.	2,416	3	—	15	17
Wabash	2,473	7	12	16	19
B. & M.	2,516	—	3	7	—
C. & O.	2,558	—	10	—	19
D. & R. G. W.	2,604	4	—	20	20
S. A. L.	3,563	6	—	7	7
U. P.	3,665	7	12	16	19
A. C. L.	4,597	1	1	7	7
S. T. L. & S. F.	4,769	—	—	20	21
L. & N.	5,038	—	—	—	1
B. & O.	5,187	26	37	45	49
I. C. Sys.	6,180	—	8	19	33
N. P.	6,656	—	—	1	3
S. P.	7,118	2	4	25	27
C. R. I. & P.	8,123	3	37	133	143
G. N.	8,266	—	—	—	2
C. B. & Q.	8,389	—	—	6	23
C. & N. W.	8,402	10	22	22	22
A. T. & S. F.	8,862	—	20	75	97
M. P.	7,343	—	3	3	8
U. P. Sys.	9,483	8	14	23	31
C. M. & St. P.	10,261	—	—	21	26
Penna.	10,531	36	46	100	—
Can. Nat'l	21,923	—	—	18	47

* Note: A dash (—), indicates that either no information was available or that such applications were not in service.

up by the use of material handling machinery. Table 5 shows industrial truck development since 1916.

Electric heating devices are a factor of ever increasing importance. The characteristics of electric heat make it economical for use in heating rivets, heat treating of steel, drying and baking armature coils, melting lead or bab-

TABLE 5

INDUSTRIAL TRUCKS

Railroad	Mileage	Year 1916	1918	1922	1923
P. & L. E.	225	*—	—	31	31
D. L. & W.	981	4	22	32	39
C. of G.	1,924	8	—	—	50
N. Y., N. H. & H. Sys.	2,183	2	18	70	75
N. & W.	2,238	—	1	21	21
Erie	2,309	—	11	—	22
C. & O.	2,558	—	15	—	25
I. C. Sys.	6,180	—	17	—	35
Mo. P.	7,343	—	16	16	19
C. R. I. & P.	8,123	3	15	27	27
C. B. & Q.	8,389	—	—	—	44
A. T. & S. F.	8,862	—	—	—	32
Penna.	10,531	30	—	316	—

* Note: A dash (—) indicates that either no information was available or that such applications were not in service.

bitt and for operating soldering iron furnaces, glue pots, core baking ovens, varnish drying ovens, etc.

More intensive application of electrical equipment is urgent, but in many cases railway officials have not thoroughly realized the importance of this fact.

The Committee wants to thank all those that have assisted in compiling the information that has made this report possible and hopes that the information may be of some assistance in bringing to the attention of railway officers the important part electricity is playing in improving facilities which in turn will speed up transportation.

Respectfully submitted,

COMMITTEE ON DATA AND INFORMATION.

REPORT OF COMMITTEE ON DATA AND INFORMATION, A. R. E. E. TABLE II.

Miles of line	Railroad	Car lighting data: Total passenger cars operated	Electric lighted cars owned by railway	Electric lighted cars operated by railway	Cars lighted from headlight generator	Number battery charging plants	Industrial trucks: Baggage handling	Freight house	Battery and commissary	Electric tractors	Shop trucks	Total number	Number battery charging plants	Locomotive headlights: No. equipped with incandescent headlights	Purchased or generated power in shops: Purchased power No. of shops	Hp. total connected load	Generated power No. of shops	Hp. total connected load	Generators, all classes of service: Total K. V. A. capacity A.C.
8,862	Atchison, Topeka & Santa Fe	2,007	810	364	..	16	..	11	..	..	21	32	1	2,095	19	12,667	21	10,566	6,772
4,597	Atlantic Coast Line	742	161	166	..	2	..	6	..	..	..	6	1	890	7	....	4	....	3,850
638	Atlanta, Birmingham & Atlantic	60	42	42	8	2	..	..	..	..	..	..	..	84	..	....	1	367	150
5,187	Baltimore & Ohio	1,514	686	686	137	8	2	..	..	..	7	9	2	2,646	50	30,000	21	2,500	3,500
217	Bessemer & Lake Erie	61	6	0	0	1	0	0	0	0	3	3	1	196	3	710	1	737	0
590	Buffalo, Rochester & Pittsburgh	95	47	51	..	6	..	..	..	..	2	2	1	290	7	2,904	1	1,574	1,010
21,923	Canadian National Rys.	3,181	1,000	958	8	22	..	..	..	..	7	7	..	4,257	23	19,073	7	2,108	7,702
291	Carolina, Clinchfield & Ohio	32	24	24	..	1	..	..	..	..	..	..	..	79	1	20	1	993	570
1,924	Central of Georgia	318	93	93	..	2	..	48	..	..	2	50	4	306	3	7,950	..	....	2,015
533	Central Vermont Ry.	88	20	21	..	1	..	..	..	..	1	1	1	97	7	1,062	..	....	....
343	Charleston & Western Carolina	40	2	2	..	..	..	..	..	..	..	..	..	59	..	....	..	....	....
2,558	Chesapeake & Ohio	472	363	363	..	8	..	..	..	1	24	25	5	965	14	9,612	8	3,280	2,360
1,132	Chicago & Alton	165	72	75	..	2	..	..	..	..	..	..	..	340	6	925	6	3,405	400
945	Chicago & Eastern Ill.	220	73	78	..	2	..	3	..	..	3	3	1	345	5	454	2	1,943	520
8,402	Chicago & Northwestern	1,885	355	355	12	3	1	5	..	..	1	8	5	2,300	13	10,234	11	18,807	8,696
8,389	Chicago, Burlington & Quincy	1,417	915	1,115	123	8	1	32	..	..	11	44	7	1,925	32	9,676	14	12,653	4,373
1,496	Chicago Great Western	178	63	87	..	6	..	..	..	..	3	3	1	251	3	260	1	3,050	....
654	Chicago, Ind. & Louisville	99	37	37	46	2	..	..	..	..	..	2	1	158	5	2,366	..	....	....
10,261	Chicago, Milwaukee & St. Paul	1,673	1,016	1,016	265	9	..	..	6	..	..	..	3	2,056	7	2,000	28	16,000	800
8,123	Chicago, Rock Island & Pacific	1,195	584	584	110	10	..	15	1	..	11	27	6	1,675	32	4,964	14	6,567	2,450
1,749	Chicago, St. Paul, Minn. & Omaha	339	56	56	..	1	..	..	..	..	..	..	..	395	4	1,255	2	1,812	1,187
2,416	C. C. C. & St. Louis R. R.	616	313	313	..	3	..	..	..	..	..	..	..	932	26	3,714	8	9,701	1,500
...	Colorado Southern	155	36	36	1	1	..	..	..	..	..	..	..	188	2	160	1	1,136	....
873	Delaware & Hudson	431	77	77	..	2	..	..	..	..	1	1	..	386	7	5,150	1	900	400
981	Delaware, Lackawanna & Western	1,044	336	386	..	1	9	21	..	..	9	39	9	779	3	6,800	2	4,106	2,700
2,604	Denver & Rio Grande Western	349	104	56	..	2	..	..	..	..	..	..	..	540	9	3,600	..	....	....
194	Duluth & Iron Range	27	2	2	0	1	..	..	..	..	..	..	..	110	3	160	1	3,281	900
459	Elgin, Joliet & Eastern	...	...	..	..	..	..	..	..	..	2	2	2	248	9	4,528	..	....	38
1,140	El Paso & Southwestern	89	39	39	..	1	..	..	..	..	..	..	..	154	2	90	1	898	....
2,309	Erie Railroad	1,287	411	440	0	3	..	7	..	..	15	22	7	1,589	31	17,234	2	3,816	250
...	Grand Trunk, Western Lines	...	34	..	8	3	..	..	..	..	2	2	..	323	2	2,818	..	....	200
8,266	Great Northern	1,124	680	680	..	3	8	..	7	..	2	17	6	1,419	5	7,736	3	2,839	11,825
1,173	Gulf Coast Lines	87	27	27	..	1	..	..	..	..	..	..	..	94	..	....	1	600	450
437	Gulf, Mobile & Northern R. R.	36	2	4	0	1	..	..	..	..	..	..	..	63	1	270	..	....	....
350	Hocking Valley Ry. Company	71	16	16	..	1	..	..	..	..	..	..	..	164	2	3,874	..	....	....
6,180	Illinois Central R. R. (and Yazoo & Mississippi Valley)	1,261	527	527	..	15	6	25	..	..	4	35	6	1,804	27	14,941	6	8,237	5,600
425	Illinois Traction System	115	115	115	..	..	..	..	..	..	..	..	..	29	1	574	..	....	....
1,160	International & Great Northern	122	12	12	..	1	..	..	..	..	..	..	..	182	3	1,967	..	....	....
836	Kansas City Southern	89	3	17	..	..	..	..	..	..	..	..	..	186	2	385	4	1,075	....
297	Lehigh & New England	11	...	..	..	..	..	..	..	..	..	..	..	64	3	974	..	....	....
1,442	Lehigh Valley	427	417	417	2	3	1	D	..	..	13	..	1,035	....	26	3,409	3	7,041	5,511
395	Long Island	1,254	882	..	..	2	..	..	..	..	4	4	1	156	14	2,118	..	....	....
5,038	Louisville & Nashville	810	361	361	..	10	..	6	..	..	..	6	2	1,343	9	3,500	7	12,031	300
1,215	Main Central	288	24	24	0	1	..	..	..	..	..	..	..	230	..	....	..	....	....
1,650	Minneapolis & St. Louis	121	29	29	..	1	..	..	..	..	..	..	..	222	2	813	..	...	....
4,348	Minneapolis, St. Paul & Sault Ste. Marie	441	162	162	..	4	..	..	1	..	4	5	..	531	..	...	2	3,047	....
.	Missouri, Kansas & Texas	435	78	78	0	5	..	..	..	..	10	10	3	683	13	4,903	3	3,648	737
7,343	Missouri Pacific R. R.	768	227	227	..	4	..	7	..	..	12	19	6	1,153	13	5,000	4	....	300
1,161	Mobile & Ohio	130	2	36	..	..	..	..	..	..	..	..	..	242	7	979	..	....	....
1,247	Nashville, Chattanooga & St. L.	235	60	..	..	2	..	..	..	..	1	1	1	278	4	1,895	1	50	185
568	New York, Ontario & Western	261	81	81	..	2	..	..	..	..	3	3	2	193	4	113	3	7,202	....
1,247	New York, Chicago & St. Louis	150	22	22	..	3	..	..	..	..	1	1	1	413	23	822	5	110	....
2,153	N. Y., New Haven & Hartford and Central New England	2,413	1,147	1,147	..	3	11	38	..	..	26	75	7	1,256	18	4,900	4	5,224	862
2,238	Norfolk & Western R. R.	577	258	[illegible]	..	6	..	..	..	..	21	21	21	1,070	7	....	6	.	4,350
6,656	Northern Pacific	1,137	602	716	..	6	..	..	..	..	5	5	3	1,439	34	7,249	7	3,372	2,744
508	Northwestern Pacific	205	65	8	..	2	..	..	..	..	..	..	..	68	4	800	..	....	....
10,521	*Pennsylvania	*6,998	*3,650	*3,650	..	..	*181	*7	..	*7	*121	*316	..	*7,549	*120	*40,883	*96	*69,192	*122,772
2,229	Pere Marquette	345	139	139	..	..	1	2	..	..	3	6	3	455	3	2,610	3	1,307	50
225	Pittsburgh & Lake Erie	130	57	57	..	1	7	24	..	..	..	31	3	318	9	1,200	7	4,800	2,215
616	Ohio Central	46	16	20	..	4	..	..	..	..	3	3	2	246	5	3,257	4	670	300
1,776	St. Louis Southwestern	233	24	24	7	1	..	..	..	..	1	1	1	281	2	259	P B	1,641	1,500
4,769	St. Louis-San Francisco	701	349	416	..	12	..	..	..	..	1	1	1	998	14	7,800	3	300	1,250
739	San Antonio & Ara. Pass	94	1	1	..	1	..	..	..	..	..	..	..	85	1	723	..	....	....
7,117	Southern Pacific Co., Pacific System	1,521	146	200	3	14	5	..	..	3	2	10	4	1,472	38	15,672	5	3,015	829
2,972	Southern Pacific Co., Texas & Louisiana	538	104	200	..	3	..	..	..	..	..	..	..	458	4	3,829	2	2,752	730
3,563	Seaboard Air Line	404	142	142	..	2	..	..	..	..	..	..	..	592	4	2,688	4	2,200	....
1,953	Texas & Pacific	297	122	113	..	1	..	..	..	..	..	..	..	381	5	2,800	2	445	450
3,709	Union Pacific	896	438	550	..	3	..	..	..	..	2	2	1	1,087	22	14,533	2	3,054	1,750
1,169	Los Angeles & Salt Lake	97	46	46	..	1	..	..	1	..	4	..	1	194	3	1,968	1	1,281	400
2,367	Oregon Short Line	293	140	157	..	2	3	..	..	..	..	3	1	407	11	6,274	..	....	100
2,238	Oregon, Washington R. R. & Navigation	245	150	150	..	5	..	..	..	..	..	..	..	310	11	3,823	3	461	....
526	Virginian	66	17	20	..	3	..	..	..	..	1	1	1	....	5	7,210	2	570	150
2,473	Wabash	418	112	7	..	3	..	..	..	..	2	2	1	615	14	8,142	..	....	750
702	Western Maryland	120	53	..	..	4	..	..	..	..	2	2	2	308	11	9,980	1	587	950
512	Wheeling & Lake Erie	81	5	5	..	4	..	2	..	..	1	3	1	214	4	116	4	3,091	495

Railroad	Generators: No. of generators A.C.	Total K.W. capacity D.C.	No. of generators D.C.	Motors: Total No. D.C.	Horsepower	No. A.C. single phase	Horsepower	No. A.C. two phase	Horsepower	No. A.C. three phase	Horsepower	Sizes D.C.: ¾ to 10 hp. incl.	15 to 25 hp. incl.	25 to 50 hp. incl.	50 to .. hp. incl.	Sizes A.C., single phase: ½ to 10 hp. incl.	15 to 25 hp. incl.	25 to 50 hp. incl.	50 to .. hp. incl.	Sizes A.C., two phase: ½ to 10 hp. incl.	15 to 25 hp. incl.	25 to 50 hp. incl.	50 to .. hp. incl.	Sizes A.C., three phase: ½ to 10 hp. incl.	15 to 25 hp. incl.	25 to 50 hp. incl.	50 to .. hp. incl.
Atchison, Topeka & Santa Fe	57	3,028	44	460	5,500	99	111	12	134	910	17,507	262	77	77	16	66	..	..	...	12	..	..	..	463	232	148	67
Atlantic Coast Line	5	715	7	226	2,981	6	12	129	2,110	76	1,350	142	60	15	7	6	..	..	..	64	33	20	3	38	26	12	4
Atlanta, Birmingham & Atlantic	1	242	2	13	308	..	..	..	....	5	59	4	4	3	1	..	..	..	..	..	..	..	..	3	2	..	..
Baltimore & Ohio	30	800	10	550	13,000	..	..	..	....	1,300	18,000	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bessemer & Lake Erie	0	768	6	127	737	2	4	..	....	5	750	70	30	8	5	2	..	..	..	..	..	..	..	1	1	1	1
Buffalo, Rochester & Pittsburgh	6	850	5	134	1,692	10	10	22	267	129	2,627	80	35	12	3	5	..	..	..	13	6	3	0	65	35	19	10
Canadian National Rys.	46	3,645	51	303	4,340	44	39	48	1,547	5,957	29,407	178	65	49	8	37	..	..	..	..	..	..	..	759	392	219	116
Carolina, Clinchfield & Ohio	2	510	3	47	993	..	..	..	....	2	85	21	19	3	4	..	..	..	..	..	..	..	..	..	..	..	..
Central of Georgia	9	427	5	133	1,638	..	..	5	133	285	6,179	76	29	10	..	..	..	..	..	1	1	3	..	134	75	39	..
Central Vermont Ry.	..	....	..	....	....	..	..	..	....	49	1,062	....	..	..	..	..	..	..	..	..	..	..	..	24	15	9	1
Charleston & Western Carolina	..	....	..	....	....	..	..	..	....	....	....	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chesapeake & Ohio	7	1,385	31	196	7,489	12	18	..	....	438	11,087	107	38	19	32	12	..	..	..	..	..	..	..	251	83	59	45
Chicago & Alton	2	885	8	202	2,768	..	..	7	180	98	1,382	112	70	16	4	..	..	..	..	..	5	2	..	57	29	4	8
Chicago & Eastern Ill.	3	600	2	112	1,508	..	..	..	....	34	889	81	54	8	..	..	..	..	..	..	..	..	..	13	9	11	1
Chicago & Northwestern	16	5,228	43	509	8,109	16	60	..	....	926	22,004	338	54	69	12	14	2	..	..	..	..	..	..	412	251	168	95
Chicago, Burlington & Quincy	14	4,307	65	570	9,854	14	70	1	25	712	13,201	321	144	83	22	13	1	..	..	..	1	..	..	402	168	104	38
Chicago Great Western	..	900	5	126	3,050	..	..	2	50	88	1,940	61	44	17	4	..	..	..	..	1	..	1	..	28	34	14	12
Chicago, Ind. & Louisville	..	....	..	18	208	..	..	..	....	90	2,366	14	..	3	1	..	..	..	..	..	..	..	..	29	17	14	5
Chicago, Milwaukee & St. Paul	4	15,000	50	574	16,203	..	..	..	....	107	14,565	196	136	227	16	..	..	..	..	..	..	..	..	66	19	9	13
Chicago, Rock Island & Pacific	4	2,287	31	330	4,851	5	5	27	771	327	5,904	182	109	36	3	5	..	..	..	7	10	8	2	166	105	46	10
Chicago, St. Paul, Minn. & Omaha	5	540	10	98	1,470	1	8	43	486	140	2,010	54	14	20	1	1	..	..	..	28	12	3	..	86	39	14	1
C. C. C. & St. Louis R. R.	3	2,145	12	321	5,812	2	25	..	....	383	7,703	185	86	39	11	1	1	..	..	..	..	..	..	227	80	43	21
Colorado Southern	..	375	3	73	1,176	..	..	..	....	2	70	34	27	10	2	..	..	..	..	..	..	..	..	..	..	2	..
Delaware & Hudson	1	350	1	164	2,784	18	45	1	25	206	3,626	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Delaware, Lackawanna & Western	8	....	..	456	6,051	2	25	..	....	767	11,510	313	77	53	13	1	1	..	..	..	..	..	..	506	169	65	27
Denver & Rio Grande Western	..	....	..	....	....	..	..	..	....	170	3,500	....	..	..	..	..	..	..	..	..	..	..	..	63	46	29	19
Duluth & Iron Range	2	115	2	36	240	3	10	..	....	147	3,431	32	3	1	..	3	..	..	..	..	..	..	..	48	19	72	8
Elgin, Joliet & Eastern	1	38	4	7	170	6	15	..	....	201	4,343	2	1	4	..	6	..	..	..	..	..	..	..	113	47	28	13
El Paso & Southwestern	..	400	8	62	898	..	..	8	130	....	....	38	12	11	1	..	..	..	..	2	5	1	..	..	..	..	..
Erie Railroad	3	1,117	7	302	6,454	45	3,223	81	2,341	386	9,032	153	87	37	25	7	3	..	34	32	18	21	10	144	132	81	29
Grand Trunk, Western Lines	1	212	4	82	1,095	11	3	..	....	204	4,027	49	8	23	2	..	..	..	..	..	..	..	..	94	54	41	15
Great Northern	18	125	4	8	320	2	6	2	25	1,076	19,832	....	..	6	..	2	..	..	..	1	..	..	..	477	374	112	102
Gulf Coast Lines	2	....	..	....	....	..	..	..	....	8	400	....	..	..	..	..	..	..	..	..	..	..	..	..	4	3	1
Gulf, Mobile & Northern R. R.	..	....	..	....	....	..	..	..	....	6	270	....	..	..	..	..	..	..	..	..	..	..	..	1	1	3	1
Hocking Valley Ry. Company	..	....	..	7	100	..	..	..	....	211	4,015	5	..	2	1	..	..	..	..	..	..	..	..	120	50	36	6
Illinois Central R. R. (and Yazoo & Mississippi Valley)	12	550	4	87	1,481	9	50	1	10	1,558	23,176	43	30	10	4	9	..	..	..	1	..	..	..	986	402	128	42
Illinois Traction System	..	....	..	8	72	3	1	..	....	32	500	6	2	..	..	1	..	..	..	..	..	..	..	22	6	2	2
International & Great Northern	..	....	..	12	127	..	..	11	172	49	1,668	9	3	..	..	..	..	..	..	5	5	1	..	8	6	33	2
Kansas City Southern	..	917	7	165	1,075	..	..	..	....	6	85	100	25	39	1	..	..	..	..	..	..	..	..	3	3	..	..
Lehigh & New England	..	....	1	....	....	..	..	..	....	47	974	....	..	..	..	..	..	..	..	..	..	..	..	29	11	3	4
Lehigh Valley	9	839	18	154	2,678	5	8	209	4,383	130	2,557	26	13	8	4	5	..	..	..	34	28	24	6	62	44	22	8
Long Island	..	....	..	....	....	..	..	..	....	88	2,118	....	..	..	..	..	..	..	..	..	..	..	..	45	21	14	8
Louisville & Nashville	2	6,500	12	276	12,413	22	66	3	52	150	3,000	33	76	83	62	22	..	..	..	2	1	..	..	14	60	61	5
Main Central	..	....	..	....	....	6	5	6	174	113	1,359	....	..	..	..	..	..	..	..	..	..	..	..	76	19	14	2
Minneapolis & St. Louis	..	....	..	5	115	..	..	..	....	39	788	2	2	1	..	..	..	..	..	..	..	..	..	11	25	2	1
Minneapolis, St. Paul & Sault Ste. Marie	..	1,910	17	221	3,047	..	..	..	....	....	....	139	38	40	4	..	..	..	..	..	..	..	..	..	..	..	..
Missouri, Kansas & Texas	7	2,104	26	309	4,753	7	11	2	41	180	3,746	177	63	64	6	7	..	..	..	1	..	1	..	109	43	15	14
Missouri Pacific R. R.	4	2,610	17	364	6,359	..	..	5	119	28	1,064	204	99	44	17	..	..	..	..	2	1	2	..	11	6	7	4
Mobile & Ohio	..	65	3	2	57	..	..	9	77	60	844	1	..	..	1	..	..	..	..	8	1	..	..	32	22	4	2
Nashville, Chattanooga & St. L.	2	....	..	4	108	24	7	112	1,779	....	....	4	..	5	..	..	..	..	..	..	..	..	..	79	20	18	2
New York, Ontario & Western	..	1,265	11	171	2,232	8	7	..	....	14	132	96	48	9	6	8	..	..	..	..	..	..	..	..	..	11	3
New York, Chicago & St. Louis	..	125	7	37	498	2	1	4	35	53	1,250	15	17	3	..	2	..	..	..	4	..	..	..	20	15	11	7
N. Y., New Haven & Hartford and Central New England	7	232	5	18	320	12	57	14	447	471	9,300	2	11	5	..	12	..	..	..	4	1	9	..	224	90	72	10
Norfolk & Western R. R.	10	875	6	606	....	..	..	..	....	701	....	351	148	42	65	..	..	..	..	..	..	..	..	309	213	107	72
Northern Pacific	18	334	62	13	152	56	89	353	5,297	415	6,613	13	4	1	..	54	..	..	..	160	118	52	25	240	130	20	27
Northwestern Pacific	..	4,830	22	87	6,405	6	14	..	....	66	815	45	..	..	42	6	..	..	..	..	..	..	..	46	12	6	2
*Pennsylvania	*107	*20,860	*224	*3,520	*55,997	*81	*400	*950	*14,350	*2,617	*58,234	*2,090	*688	*411	*153	*63	*1	*..	*2	*521	*257	*139	*33	*1,353	*719	*342	*216
Pere Marquette	1	684	20	97	1,467	15	40	..	....	164	4,713	44	27	11	..	16	..	..	..	..	..	..	..	94	43	42	9
Pittsburgh & Lake Erie	7	1,160	9	276	3,600	2	45	..	....	180	2,212	168	55	37	9	..	1	1	..	..	..	..	..	105	59	15	1
Ohio Central	1	225	3	30	1,442	..	..	..	....	86	2,394	7	9	..	14	..	..	..	..	..	..	..	..	32	37	12	5
St. Louis Southwestern	4	500	4	77	722	..	..	..	....	70	1,168	294	238	190	..	..	..	..	..	..	..	..	..	151	432	310	275
St. Louis-San Francisco	4	205	5	116	1,750	..	..	2	300	294	8,111	63	36	9	8	..	..	..	..	..	..	..	2	116	78	47	53
San Antonio & Ara. Pass	..	....	..	....	....	2	6	..	....	56	717	....	..	..	..	2	..	..	..	..	..	..	..	41	10	2	3
Southern Pacific Co., Pacific System	5	844	30	296	5,130	84	148	75	1,410	878	15,896	194	66	16	20	83	1	..	..	47	16	7	5	570	165	98	145
Southern Pacific Co., Texas & Louisiana	5	....	..	....	....	..	..	66	1,284	243	5,297	....	..	..	..	..	..	..	..	33	18	9	6	120	70	41	12
Seaboard Air Line	..	....	..	145	2,293	3	2	4	105	168	2,472	83	43	12	7	3	..	..	..	..	1	3	..	114	31	18	5
Texas & Pacific	2	275	2	11	400	..	..	4	63	128	2,400	1	3	6	1	..	..	..	..	1	3	..	..	87	30	6	5
Union Pacific	3	1,935	9	539	6,668	..	..	..	....	803	11,239	374	119	34	12	..	..	..	..	..	..	..	..	501	197	91	14
Los Angeles & Salt Lake	2	100	1	28	300	3	3	..	....	202	3,047	22	3	3	..	3	..	..	..	..	..	..	..	146	29	16	11
Oregon Short Line	1	390	6	175	2,138	3	3	3	62	262	4,071	119	36	20	0	3	..	..	..	1	1	1	..	189	32	28	13
Oregon, Washington R. R. & Navigation	..	....	..	131	2,186	3	1	3	60	73	1,810	85	37	8	3	2	..	..	..	..	3	..	..	29	23	12	9
Virginian	1	4,724	16	...	....	..	..	..	....	....	....	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wabash	3	....	..	8	55	3	15	2	30	....	....	....	..	..	..	3	..	..	..	..	2	..	..	246	140	37	22
Western Maryland	4	655	5	135	3,765	2	2	3	70	260	6,731	81	18	10	10	2	..	..	..	1	1	1	..	58	35	20	13
Wheeling & Lake Erie	5	862	5	171	2,876	10	2	..	....	49	1,374	86	61	20	4	..	..	..	..	..	..	..	..	15	14	16	4

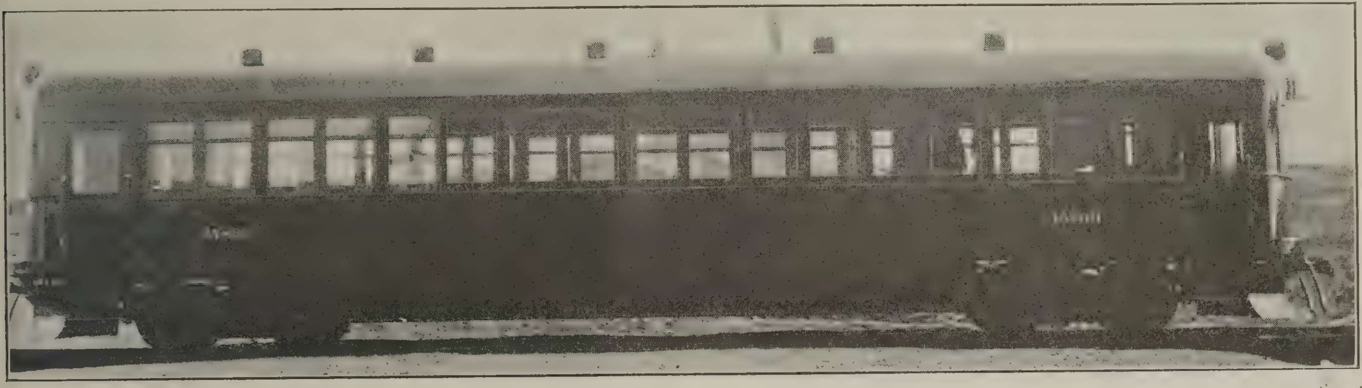
Railroad	Machine tool applications	Pumping stations: Auto control	Manual control	Coaling stations	Turntables: Turntables	Overhead or underground service	Cinder handling	Air compressor	Electric welding outfits: Total No. of sets	D.C.	A.C.	Range of ampere capacity	Single operator sets	Multiple operator sets	Automatic arcs	Butt welding machines	Spot welding machines	Semi-auto arcs	Lifting magnets: Number	Class of service	Electric rivet heaters	Other electric heating units: Number	Class of service
Atchison, Topeka & Santa Fe	510	..	142	14	30	..	1	11	97	97	..	200-600	91	6	..	1	..	..	6	G	5	2	T
Atlantic Coast Line	276	3	..	2	5	..	1	..	7	7	..	200-600	6	1	..	2	..	..	4	S	..	..	..
Atlanta, Birmingham & Atlantic	4	2	..	..	..	..	..	..	2	1	1	200	2	..	..	..	..	..	1	S	..	..	..
Baltimore & Ohio	..	..	..	..	42	O	..	..	49	49	..	150-1,000	24	25	..	..	1	..	26	..	..	2	T
Bessemer & Lake Erie	91	2	1	2	3	U	..	1	1	1	..	30-800	..	1	..	..	..	..	2	S	..	6	F
Buffalo, Rochester & Pittsburgh	240	..	1	7	11	O	9	5	4	4	..	{300-500 / 700-900}	2	2	..	..	..	..	7	S	..	..	..
Canadian National Rys.	1,231	19	22	58	10	O	2	31	47	42	5	50-500	32	15	..	..	1	..	10	G	16	28	A E H T B
Carolina, Clinchfield & Ohio	26	..	..	..	1	..	..	..	1	1	..	600	..	1	..	..	..	..	..	..	..	..	..
Central of Georgia	400	4	3	6	4	O & U	..	8	4	4	..	125	3	1	..	..	..	..	..	..	..	1	B
Central Vermont Ry.	37	2	..	3	..	..	3	2	2	0	2	0-200	..	2	..	..	..	..	1	S	..	..	..
Charleston & Western Carolina	..	..	..	..	..	..	..	..	..	..	..	......	..	..	..	..	..	..	..	..	..	..	..
Chesapeake & Ohio	436	7	11	15	13	O	..	15	19	19	..	60-208	4	13	..	..	1	..	6	S	5	2	B
Chicago & Alton	160	..	10	12	7	O & U	4	..	4	4	..	200-600	2	2	..	..	..	..	1	S	..	..	..
Chicago & Eastern Ill.	52	5	1	5	1	O	..	..	..	..	..	......	..	..	..	..	..	..	1	S	..	..	..
Chicago & Northwestern	350	6	60	36	27	Q	10	5	22	22	..	0-600	19	3	..	..	1	..	5	S & G	..	2	L
Chicago, Burlington & Quincy	749	33	20	33	15	O	5	24	23	23	..	200	22	1	..	2	..	..	6	S	1	..	..
Chicago Great Western	27	2	1	4	8	O & U	..	4	3	3	..	50-150	2	1	..	..	..	..	2	S	..	..	..
Chicago, Ind. & Louisville	53	..	..	4	3	O	..	5	5	5	..	50-300	5	..	..	..	..	..	1	S	..	..	..
Chicago, Milwaukee & St. Paul	314	13	40	43	37	O	..	1	26	25	1	0-7,000	25	9	..	..	..	..	11	G	..	..	..
Chicago, Rock Island & Pacific	30%	..	..	..	26	O	..	1	143	143	..	150-300	143	..	..	1	..	..	7	S & G	3	..	..
Chicago, St. Paul, Minn. & Omaha	219	..	8	5	9	O & U	2	1	1	1	..	200	1	..	..	..	..	..	1	S	..	1	T
C. C. C. & St. Louis R. R.	623	26	11	17	19	O & U	..	10	17	17	..	150-800	16	..	..	..	..	..	3	S	..	..	..
Colorado Southern	68	..	..	1	2	O	1	1	2	2	..	60-225	2	..	..	..	..	..	1	S	..	..	..
Delaware & Hudson	118	3	7	14	15	O	9	12	4	1	2	200-900	3	1	..	..	..	..	3	G	..	65	J K
Delaware, Lackawanna & Western	531	..	2	13	23	U	25	22	15	14	1	0-300	12	3	..	..	1	..	7	S	2	9	K M
Denver & Rio Grande Western	..	..	..	1	3	U	..	7	20	20	..	0-200	19	1	..	..	..	..	..	..	..	..	..
Duluth & Iron Range	78	..	5	..	3	..	..	1	2	2	..	0-300	2	..	2	1	..	..	2	S	..	10	A N
Elgin, Joliet & Eastern	98	6	14	9	6	O	9	8	2	..	2	0-700	1	1	..	..	..	..	2	S & G	..	..	..
El Paso & Southwestern	53	..	5	1	1	U	..	2	2	2	..	200-300	2	..	..	..	..	..	..	..	..	..	..
Erie Railroad	206	10	..	8	20	O	..	9	55	55	..	150-600	22	33	..	..	..	..	3	S & G	..	..	..
Grand Trunk, Western Lines	280	4	2	3	4	U	..	4	19	..	..	100-600	8	11	..	1	1	3	3	S & G	2	20	J K
Great Northern	295	25	..	16	18	O	2	11	2	2	..	0-150	2	..	..	..	..	..	2	S	..	1	Y
Gulf Coast Lines	8	..	..	..	..	..	..	..	2	..	2	0-300	2	..	2	..	..	..	..	..	..	..	..
Gulf, Mobile & Northern R. R.	5	..	..	..	..	..	..	..	1	1	..	0-600	1	..	1	..	..	..	..	..	..	..	..
Hocking Valley Ry. Company	..	2	6	6	5	O & U	..	5	5	5	..	0-300	5	..	..	1	..	..	2	5	..	5	A B
Illinois Central R. R. (and Yazoo & Mississippi Valley)	1,364	25	34	31	39	O & U	11	54	33	22	11	0-300	33	..	..	5	1	..	9	6	14	22	G
Illinois Traction System	38	1	3	..	..	..	..	1	4	..	..	0-350	4	..	..	..	..	..	..	..	..	3	B
International & Great Northern	68	..	2	..	1	U	..	1	4	4	..	175-400	4	..	..	..	..	..	..	..	..	..	..
Kansas City Southern	35	..	5	..	4	O	..	..	4	4	..	0-300	3	1	..	..	..	..	..	..	..	1	T
Lehigh & New England	31	..	..	2	1	O	..	2	..	..	..	......	..	..	..	..	..	..	..	..	..	..	..
Lehigh Valley	214	1	4	10	12	O & U	14	2	12	4	8	0-800	5	7	..	1	..	..	4	S	2	12	N W
Long Island	..	..	..	..	3	..	1	3	2	..	..	0-500	..	..	..	..	..	..	2	S	1	1	B
Louisville & Nashville	..	6	3	12	21	O & U	3	1	1	..	..	......	1	..	..	..	..	..	1	G	..	3	B N
Main Central	81	1	1	1	4	..	2	3	1	..	..	0-300	1	..	..	..	..	..	1	S	..	..	..
Minneapolis & St. Louis	11	5	14	1	5	O	..	..	..	..	..	......	..	..	..	..	..	..	..	..	..	..	..
Minneapolis, St. Paul & Sault Ste. Marie	217	..	..	2	2	..	..	..	2	2	..	0-300	2	..	..	..	..	..	2	S	..	2	N
Missouri, Kansas & Texas	..	1	1	8	4	..	..	6	8	7	1	0-600	7	1	..	..	..	..	7	S & G	2	..	..
Missouri Pacific R. R.	370	1	12	3	8	O & U	..	2	8	5	3	0-510	5	3	..	..	..	..	3	S	..	..	..
Mobile & Ohio	..	..	..	..	..	..	..	..	1	1	..	0-150	..	..	..	..	..	..	1	S	..	..	..
Nashville, Chattanooga & St. L.	82	9	..	13	3	..	1	3	8	8	..	0-150	7	1	..	1	1	..	2	G	..	1	T
New York, Ontario & Western	178	3	3	5	1	O	2	4	7	7	..	0-300	7	..	..	..	..	..	..	..	..	..	..
New York, Chicago & St. Louis	32	3	..	..	14	O & U	1	1	10	2	8	0-300	8	2	..	..	..	..	4	S	..	..	..
N. Y., New Haven & Hartford and Central New England	410	19	..	16	16	U	10	7	19	8	11	0-200	17	2	..	..	..	..	4	G	2	163	P
Norfolk & Western R. R.	..	..	..	9	20	O	45	8	25	25	..	60-75	..	21	..	2	2	..	35	G	1	3	T
Northern Pacific	..	11	21	30	27	..	8	8	3	3	..	0-300	3	..	..	..	..	..	5	S & R	..	19	N
Northwestern Pacific	58	3	1	..	1	..	..	..	1	1	..	200	1	..	..	..	..	..	..	..	..	5	N
*Pennsylvania	..	..	..	..	..	..	..	..	*100	*96	*4	*0-3,900	*55	*43	..	..	*2	..	48	G	..	..	..
Pere Marquette	126	19	3	12	7	U	1	8	5	3	2	0-150	5	..	5	..	..	..	3	S	..	..	..
Pittsburgh & Lake Erie	408	..	15	12	8	U	9	6	4	4	..	0-800	3	1	..	..	..	..	5	G	..	..	..
Ohio Central	28	2	4	4	3	O	..	2	4	4	..	0-1,000	2	1	..	..	..	..	2	S & G	..	..	..
St. Louis Southwestern	133	1	3	5	3	..	..	2	..	..	..	......	..	..	..	..	..	..	2	S & G	..	..	..
St. Louis-San Francisco	362	..	29	5	8	U	..	10	21	10	11	50-250	21	..	..	1	..	..	2	S & G	1	10	A B V
San Antonio & Ara. Pass	53	1	..	..	..	..	..	4	3	3	..	0-150	3	..	..	..	..	..	..	S	..	..	..
Southern Pacific Co., Pacific System	1,007	68	26	1	12	O & U	..	39	27	23	4	0-300	27	..	3	1	2	..	11	S & G	3	13	N W
Southern Pacific Co., Texas & Louisiana	193	..	..	..	7	O	..	2	8	6	2	0-200	8	..	..	..	1	..	2	S	..	..	..
Seaboard Air Line	..	..	..	..	..	..	..	..	7	7	..	0-600	5	2	..	..	..	..	2	..	..	..	..
Texas & Pacific	104	..	..	..	4	..	..	2	9	9	..	0-800	3	1	..	..	..	..	1	S	..	..	..
Union Pacific	994	..	39	53	23	O & U	..	2	19	16	3	0-1,500	1	15	..	3	..	..	9	G	..	3	T B
Los Angeles & Salt Lake	134	3	..	..	..	..	..	4	4	..	..	0-200	4	..	..	..	..	..	1	S	..	..	..
Oregon Short Line	390	12	6	13	8	O	1	7	4	..	..	0-200	4	..	..	..	..	..	4	S & G	1	15	B V N X
Oregon, Washington R. R. & Navigation	135	5	..	7	6	O & U	..	4	4	4	..	0-185	4	..	..	..	..	..	1	S	1	..	..
Virginian	..	..	..	..	..	..	..	..	..	..	..	......	..	..	..	..	..	..	..	..	..	..	..
Wabash	413	2	5	8	8	O	6	17	6	6	..	0-325	6	..	..	..	..	..	2	G	1	10	J K
Western Maryland	178	5	1	14	6	O & U	5	8	22	10	12	0-500	..	..	..	..	..	..	6	G	..	..	..
Wheeling & Lake Erie	88	3	2	6	8	O	..	4	4	4	..	0-200	4	..	..	..	..	..	1	S	..	..	..

(..) Indicates that either no information was available or that such applications were not in service.
* Data as of 1922.
A—Glue pots.
B—Baking ovens.
C—25 overhead service and 1 underground service.
D—14 tractors and 134 unit trucks.
E—Heating pump house.
F—Air warming.
G—General.
H—Heat treating.
J—Heating turntable.
K—Heating crane cab.
L—Annealing.
M—Snow melting.
N—Space heaters.
O—Overhead service.
P—Heating multiple unit cars and trailers.
Q—2 overhead, 25 underground.
R—Rails.
S—Scrap.
T—Tempering.
U—Underground service.
V—Water stills.
W—Cooking.
X—Soldering.
Y—For keeping riser at storage tank at water power plant free from ice.

Report of Committee on Self-Propelled Rail Cars

Characteristics of Different Types of Cars Make Them Suitable for Certain Classes of Service

Committee:—
E. B. Walker, chairman, Electrical Engineer, Canadian National Railways; E. Wanamaker, Electrical Engineer, Chicago, Rock Island & Pacific Railway; Geo. Dodds, Electrical Engineer, Delaware & Hudson Railway; Geo. Shirk, Chief Electrician, Chicago & Great Western Railway.



Storage Battery Car Converted From Old Gas-Electric Car. Equipped With Four G E—261—C Motors and 260 Edison Cells A-12-H. Straight and Automatic Air Brake. This Car is Designed for a Short Shuttle Run and Has Wide Seats, Three Abreast, With a Total Seating Capacity of 96.

To the Members:

The Committee submits for consideration at the annual meeting its report on self-propelled rail unit cars:

The self-propelled or unit car has been in use on steam railways for many years, but it is only in the last decade that the interest in this class of equipment has been general. The steadily rising costs of material and labor and the keen competition from bus lines has made it necessary to find some substitute for the steam train wherever traffic is insufficient to pay operating costs, as is the case on many branch lines of steam railways.

Development of self-propelled cars has taken place almost simultaneously in different countries and along different lines, so that at present there are the following types in regular operation:

(a) Steam cars.

(b) Gasoline engine, driving through an electric generator and motors, commonly known as the "Gas-electric."

(c) Gasoline engine driving through mechanical transmission, including gear shift, clutch, etc., often called the "Straight Gas."

(d) Storage Battery cars.

(e) Diesel Electric cars.

All these types have given useful service, but all show serious limitations, so that a careful study of each operating problem should be made before the adoption of any particular type, and it must be remembered that no one type will satisfactorily supply all operations requiring a self-propelled car.

Service Motor Car. Equipped With 70 hp. Midwest Engine and Westinghouse Air Brake. Seats 38 in Main Compartment and 5 in Baggage Compartment

It is the purpose of this report to show the advantages and drawbacks of the different types and the class of service for which they are fitted. With this in view they

are considered under the classification given above.

(a)—Steam Cars

The earliest self-propelled cars were steam driven from a coal fired boiler and many of these are still in operation. The disadvantage of the bulky boilers, space for coal, dirt and heat, and the necessity for a three-man crew led to the development of the oil fired boiler at high pressure and later to the automatic type with pressure fed oil and steam at 500 to 800 lb.

In spite of these improvements the steam car cannot be considered a commercial success, due principally to boiler, and to a lesser extent, burner troubles.

The engine can be made simple and reliable, but it remains to be seen if a steam generator of sufficient capacity and reliability can be developed of small enough dimensions.

(b)—The Gas-Electric Car

This is another old idea which was commercially developed between 1908 and 1912. The most used type consists of a gasoline engine of about 175 hp. direct connected to a specially wound d.c. generator of 80 kw. with separate exciter. This set was mounted directly on the forward truck and furnished power to a standard two-motor equipment consisting of two 100 hp. interpole railway motors mounted on the same truck.

Reports of service obtained from these equipments vary widely and undoubtedly satisfactory operation depended to a large extent on careful maintenance and intelligent driving.

The difficulties arose chiefly from the fact that the large gasoline engine had not been thoroughly developed and accessibility for easy repairs and adjustment was almost entirely overlooked.

The electric equipment generally was quite satisfactory but the control was not automatic, and it was possible for a careless operator to subject the engine to sudden variations in speed by racing the engine and then connecting the load, with the result that the engine was brought immediately to a very slow speed, which must have subjected it to serious inertia stresses.

Recent developments of the gas-electric car indicate that both these difficulties have been overcome. The large gasoline engine has been carefully developed for marine work up to 250 hp. and can be relied on for continuous duty at approximately constant speeds, while the semi-automatic constant energy removes the danger of injury to the equipment by indiscriminate use of the controller.

The engine speed is kept constant by a governor, except when it is idling under no load, and consequently the stresses from inertia forces due to rapid change of speed, characteristic of the older models, are reduced to a minimum.

The constant energy control is a very important step forward as it prevents a negligent operator from subjecting the engine to any sudden increase in load or to any overload.

The electric equipment consists of a direct-connected generator with constant energy characteristics and separately excited from an exciter and a storage battery, which is also used for starting and lighting.

This power plant supplies energy to two or four standard railway type 600-volt d.c. motors. The generator operating at constant speed will supply either low voltage and high current, or vice-versa, the watts being approximately constant. This variation depends on the tractive effort required by the car, with full throttle and a governed engine, the speed tractive effort curve follows approximately an hyperbola between the limits of maximum tractive effort and maximum speed.

Gasoline Car Built By Ledoux-Jennings, Ltd., Montreal. Reo 6 Engine Driven Through Standard Transmission to Four Wheel Rear Truck With Side Rods. Seats 34 With Small Baggage Compartment. Has 5 ft. Westinghouse Compressor and Air Brakes

The speed can, of course, be reduced by closing the throttle and the tractive effort increased by connecting the two motors in series, but under no circumstances can the load on the engine be increased beyond the maximum for which the equipment was designed.

This type of gas-electric car has not been put into commercial operation as yet, but there is good reason to expect that it will give excellent results.

A further improvement in the new gas-electric car which will appeal to the operating department is the provision for double end operation when desired.

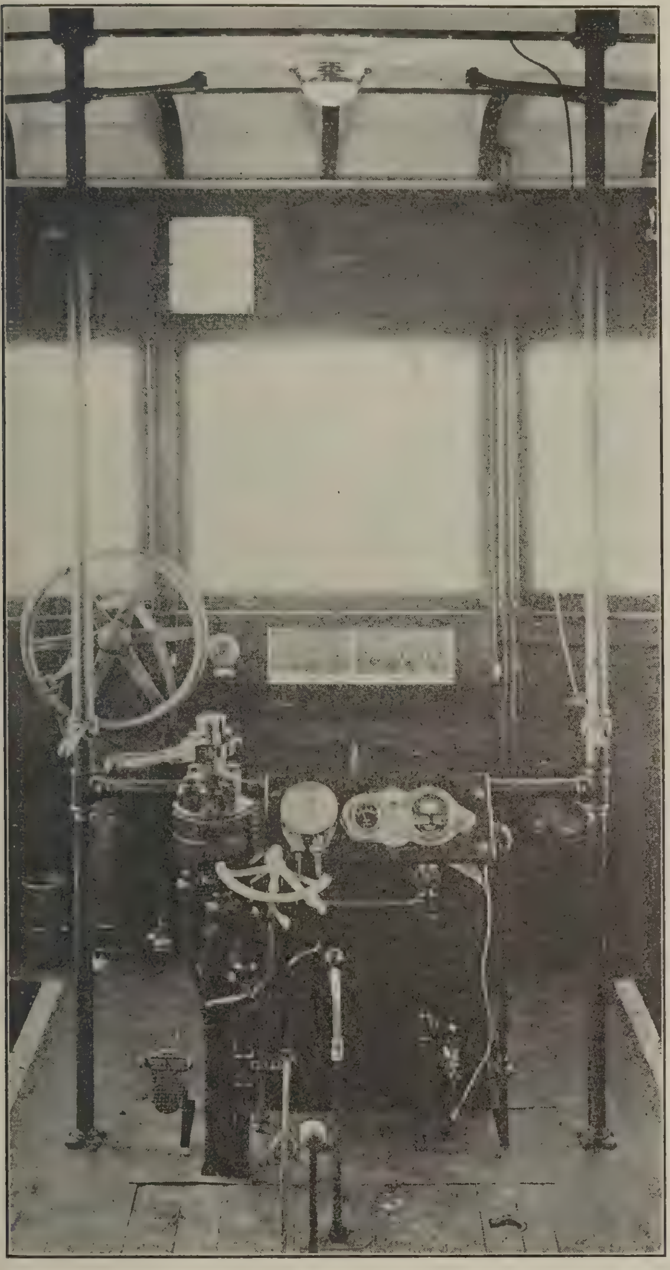
(c)—The "Straight Gas" Car

The gasoline engine driving through a mechanical transmission has been developed in many forms, from a standard motor truck chassis provided with flanged

drivers, and a four-wheel front truck to a specially built steel car 50 to 60 feet long and a 200 hp. heavy duty engine.

The engines used can be roughly divided into three classes:

(1) The light high speed, six-cylinder passenger automobile engine with a maximum of about 50 hp.:



Driver's Position of Ledoux-Jenning Car No. 15,815

(2) The four-cylinder slower speed truck engine with a maximum of about 70 hp.

(3) The heavy duty marine engine with a maximum of about 200 hp.

All the drives include the automobile type clutch and gear shift, with bevel drive to one or more axles. Where only one bevel drive is used it is customary to couple the other axle of the double truck to the driven axle by means of a chain or side rods.

Many cars of this type were quite naturally developed from a standard truck chassis by mounting flanged wheels on the rear axle and a small four-wheeled leading truck instead of the front axle.

As commercial trucks were giving excellent service on roads it seemed obvious that they should at least give as good service on a track, where grades and curves are easier, and the road surface smoother.

The real conditions are, however, very different and many unexpected troubles arose from the use of these chassis in track operation.

The average track car is heavier than a road bus on a similar chassis, and the speeds are higher, resulting in a heavier continuous load for the engine.

There are no pneumatic or rubber tires and consequently every shock from joints, frogs, etc., is transmitted through the transmission to the engine.

On curves the road car is carefully driven to avoid skidding, and besides the side thrust is partially absorbed by the rubber tires and partially by a certain amount of side slip.

Engine Room of Swedish Diesel Electric Locomotive 260 hp. Showing 12 Cylinder "V" Type Engine

In the track cars curves are taken at higher speeds and owing to the steel flanges there is no easing of the side thrust, with the result that axle bearings which give excellent service in road work, are often crushed to pieces in a track car.

The gasoline engine has an inherent cyclical variation in speed and every universal joint causes additional variations. These are transmitted through from engine to track in a series of minute shocks, which will eventually cause the failure of some portion of the engine or transmission, unless some method of absorbing these shocks is devised, or unless the various portions of the transmission and the weight of the car are carefully proportioned to the power of the engine, and the schedule is arranged so that it can easily be maintained, without driving continuously at full throttle.

The single truck axle rides very badly on a track as the

wheels find every bad joint, frog or other depression.

The above list of difficulties led to various improvements; the single driving axle was replaced by a four-wheeled truck, axle bearings were enlarged and the transmission strengthened. These improvements, together with the demand for a better class of body increased the weight of many designs to a point where the load was too great for the engine, with the result that larger engines were installed.

The larger gasoline engines are not suitable for direct mechanical transmission of power at varying speeds on account of the pulsating torque as outlined above, and it is, therefore, recommended that the "straight gas" car should be designed to be within the capacity of the light, high speed engine and to have as little superfluous weight as possible with a power-weight ratio of from 3 to 3½ hp. per ton and limited to 30,000 lb. gross weight.

Many of the troubles experienced with this type of car are due to its capacity for high speed and the ease with which it can be replenished with gasoline, oil and water.

These characteristics are apt to lead the transportation department to impose too high schedule speeds and too many miles per day.

For successful operation this class of car should not exceed 20 miles per hour schedule speed, and there should be sufficient time every day, *during daylight,* for inspection and minor adjustments.

Some railroads are experimenting with gasoline engine drives and hydraulic transmission. This appears to be the most promising method of using advantageously the power of a large gasoline engine without resorting to electric transmission. The advantages of double end control and the partial absorption of transmission shocks through the hydraulic medium should make the system attractive although there is not sufficient experience available at present on which to base any reliable conclusions.

(d)—The Storage Battery Car

This type of car has been more fully developed than any other unit car. No further major improvements are to be expected, but there will be the usual improvements in detail from time to time and probably an increase in the capacity-weight ratio of the battery, with, it is hoped, a reduction in price.

The storage battery car was developed about thirty years ago, but the early models were both mechanically and electrically inefficient and the batteries were heavy and had very short life.

The modern battery car is exactly the same in principle but the detail improvement is so great that it is now possible to design a 55-ft. battery car with a capacity of 140 miles per charge and a maximum speed of 45 miles per hour. This has been brought about by a careful reduction in weight, ball bearings, efficient motors and the high capacity-weight ratio and long life of the nickel-iron battery.

Experiments are also being made with the latest types of lead battery.

The battery car has distinct limitations, as it can only be operated where electric power is available, and its daily mileage must be distributed to allow for charging. This charging period, however, allows time for the proper inspection and maintenance of the car, which is essential to the operation of any self-propelled car.

Swedish Diesel Electric Combined Baggage Car and Locomotive 160 hp.

The simplicity of control, quiet running, double end operation, cleanliness and reliability of this car makes it very attractive from the operating standpoint, and it always wins the approval of the traveling public.

An advantage in this car is that any number can be operated in a multiple unit train, or a mixture of motor cars and trailers can be combined to give very cheap operation for small trains.

A possible development of the battery car consists in the addition of a gasoline engine driven generator of sufficient capacity to supply the average requirements of the car, the battery acting as a reservoir or regulator.

This idea has been tried many times without success, but it is felt that the recent improvements in the electrical

equipment, gasoline engines and batteries might make such a combination useful for special operating conditions, although it would be more complicated than the battery car and less efficient than the straight gas car.

(e)—The Diesel Electric Car

The Diesel-electric is substantially the same as the gas-electric, except that a Diesel engine, using cheap fuel oil, is used in place of the gasoline engine.

This development has been almost entirely in Europe, chiefly in Sweden. The high cost of gasoline in Europe makes the gas-electric car far too expensive to operate and consequently self-propelled cars have all been designed for cheap fuels.

The development of the high speed multi-cylinder Diesel engine made the Diesel electric car possible, and it is now manufactured with four-sized power plants:

75 hp.	6	cylinder,	in line	—	550 r.p.m.
120 hp.	6	"	"V"	—	500 r.p.m.
160 hp.	8	"	"V"	—	500 r.p.m.
260 hp.	12	"	"V"	—	500 r.p.m.

The two larger sizes are used in small locomotives.

Very satisfactory operating reports are received from these cars, based on ten years' experience. The fuel costs are extremely low, and maintenance does not appear to be expensive. However, it must be remembered that cheap skilled labor is easy to obtain in Europe, and that the maintenance of such engines in North America would probably be a far larger item.

While there is no doubt that Diesel engined cars will eventually take their place in North America, it is felt that at present the lower capital cost, light weight and simple maintenance of the gasoline engine more than compensates for the higher cost of gasoline at present.

Bearings

As most self-propelled cars have limited capacity in their power plant or storage battery, the use of anti-friction bearings is of the utmost importance. Tests show that the starting effort is reduced by about 75 to 80 per cent and the continuous power for running by 25 to 30 per cent.

Bearings should be chosen with a large factor of safety and liberal provision made for end thrust. It is desirable that an outside mounting be arranged for the journal boxes wherever possible and that some sort of taper sleeve be used to carry the inner races so that replacement of the entire journal box can be quickly and easily accomplished and repairs or replacements of bearings can be made under favorable conditions on the bench.

Storage Battery Car Built by the J. G. Brill Co., Equipped With Four Westinghouse Type V-65-A-3 Motors and 264 Cells A-12-H Edison Storage Battery. Note Special Battery Box Ventilation and Snow Plow Pilots. Seats 30 in Main Compartment and 20 in Smoking Compartment. A 12 ft. Baggage Space.

Recommendations

1. Of the several types of self-propelled cars described only three are to be recommended to operating officials for regular and reliable service.

These are the light straight gas car, the storage battery car and the gas-electric in its improved form.

This conclusion is based on operating experience as regards the first two types, but no actual operating data is available at present for the new type of gas-electric, although it is felt that experience with the older type would justify the anticipation of satisfactory results.

2. It is recommended that schedule speeds should not exceed 20 miles per hour for the straight gas car, and 25 miles per hour for the battery and the gas-electric cars.

It is recognized that higher speeds are practicable for long runs with few stops, but as the operation of self-propelled cars tends to an increase in the number of stops as the traffic increases it is felt that 25 miles per hour is sufficiently high schedule speed for most operations.

3. No self-propelled car should operate on a daily schedule exceeding 250 miles per day.

4. Any operation of a self-propelled car should allow of sufficient time in a car shelter, which should be heated in winter for a daily inspection by *daylight*.

5. Some individual who is of the right temperament should be made responsible for the care and maintenance of the cars and his suggestions should receive careful attention.

Ordinary terminal maintenance forces are rarely to be relied on for satisfactory service to self-propelled cars.

6. In selecting a car for any operation it is recommended that the following be used as a guide:

(a) The straight gas car is low in first cost, and can be used advantageously in any temporary operation, or any branch line with light traffic and slow schedule.

(b) The battery car can be used wherever electric power is available and should be adopted for high class service and long runs on branch or main lines.

(c) The gas-electric is recommended in place of the battery car wherever there is no electric power available at low rates, or where the schedule required does not allow for proper charging.

7. It is felt that the development of the steam cars and large engined straight gas cars has not yet passed beyond the experimental stage, and that they should not be considered for regular service, except for investigation, in which case a spare car of a more reliable type should be available if the good will of the traveling public is to be retained.

8. *Winter Operation.*

For winter operation where there is a heavy snow to be encountered the battery car will be found to have marked advantages. It has traction on all wheels and its weight insures sufficient adhesion. It has a tractive effort of 2,400 lb. at the one hour rating and 4,500 lb. for short periods. With motors in series position, this car, if equipped with a suitable snow pilot, will cut its way through long stretches of heavy snow without causing too great a battery discharge.

9. In conclusion your Committee wish to state that this report represents only a general investigation of the subject, and that, as new ideas are continually being developed, it is recommended that the investigation be continued by a future committee, with a view to ascertaining the best type of cars for various services with recommendations as to specifications, construction and limitations in size, according to the type of propulsion.

Respectfully submitted,

Committee on Self-Propelled Rail Unit Cars.

Built by the J. G. Brill Co., Equipped With Four Westinghouse V-65-A-3 Motors and 110 Cells of MV-X-33 Exide Battery. Seats 30 in Main Compartment and 10 ft. Baggage Space

Report of Committee on Insulated Wires and Cables

Various Technical Sub-Committees Have Been Active and Have Made Progress

Committee:—

J. R. Sloan, representative, chief electrician, Pennsylvania System; L. S. Billau, assistant electrical engineer, Baltimore & Ohio Railroad; J. L. Minick, assistant engineer, Pennsylvania Railroad.

To the Members:

A meeting of the American Engineering Standards Sectional Committee on Insulated Wires and Cables was called for May 18, 1923, in the A. S. M. E. Council Room, Engineering Societies Building, 29 West 39th street, New York.

Fifteen of the twenty-four members of the Committee attended, making a quorum.

The officers and Executive Committee were unanimously re-elected to serve for the year 1923-1924.

The Technical Association of the Pulp and Paper Industry were invited to nominate a representative to serve on Technical Committee No. 5—Paper Insulation.

Reports were received from the various technical subcommittees as to the progress of the section of the work which had been assigned to them.

These reports showed that as a whole the technical subcommittees had been quite active and had made fair progress.

The American Railroad Association—Signal Section was designated as a co-operating society and announced as its representative: E. G. Stradling, Supt. Tel. & Signals, Chicago, Indianapolis & Louisville Ry. Co.

L. Clark, president of the Safety Insulated Wire and Cable Co., was appointed a special member of the Sectional Committee.

The next meeting will be held subject to the call of the chairman.

Respectfully submitted,

J. R. Sloan,

Representing the A. R. E. E.

Report of Committee on Heavy Electric Traction

Notes on Distribution Systems and Sub-stations With Reference to the Probable Increase in Traffic

Committee:—

J. R. Sloan, chairman, chief electrician, Pennsylvania System; J. H. Davis, electrical engineer, Baltimore & Ohio Railroad; E. H. Hagensick, electrical engineer, Union Pacific Railroad; E. Marshall, electrical engineer, Great Northern Railroad.

To the Members:

Your Committee has not heretofore discussed this question, although it has presented data as to equipment that has been installed.

It was the thought of the Committee that a short presentation of some of the features pertaining to these two links in the general scheme of electrification might be of interest.

No attempt will be made in this discussion to enter into the technical details further than may be necessary to bring out the points it is desired to call to your attention, as articles describing in detail existing electrifications and electrification work in progress have been written, and these articles have covered quite thoroughly the salient engineering features.

Neither is it our object to discuss the relative merits of alternating and direct current as the propelling power. However, in the analysis of any electrification problem the relative advantages and disadvantages of these two methods must be compared before a proper solution of the problem can be obtained.

It must also be recognized that the result of this comparison is only one of the factors on which the ultimate solution of the entire problem is based.

In the analysis of any electrification problem there is necessarily a large amount of preliminary investigation to be made in order to determine the power requirements at various points of the section of road to be electrified.

Also as the volume of traffic to be handled increases normally from year to year there is a constant tendency to increase the number of cars per train which in turn requires an increase in the power required to haul the train which is met by increasing the drawbar pull of the locomotive.

These train movements and the power requirements occasioned by them determines the number and approximate location of the sub-stations for any given trolley voltage that may be assumed.

With either alternating or direct current operation the power is delivered to these sub-stations from the power plant over a high potential line and through transformers is reduced in voltage to that required on the low tension side of the sub-station.

With alternating current operation these sub-stations are simply transformer sub-stations, the low tension side being the trolley voltage. These stations may be housed or not as desired.

With direct current operation, however, a second transformation must be made from alternating to direct current, this transformation being effected by either motor generator sets or rotary converters.

Such equipment requires housing and constant attendance unless the equipment be made to operate automatically.

As mentioned above the volume of traffic determines the capacity and approximate location of the sub-stations and this volume of traffic normally increases from year to year.

This probable increase of traffic should, therefore, be given consideration with the view that if the transmission and distribution system cannot be initially installed to take care of the probable increased capacity in these two links, when the load outgrows the system as installed, the cost of increasing the capacity be not excessive.

From the standpoint of distribution alone it is obvious that the higher the trolley voltage, regardless whether the propelling power be alternating or direct current, the less will be the expense for trolley copper or the greater the permissible distance between sub-stations.

The capacity of the transmission line can be increased by changing the step up transformers so as to impress a higher voltage on the line.

When the trolley voltage is comparatively low its capacity may be increased by changing transformers if a. c. power be used or by duplicating the sub-station equipment if d. c. power be used, at the same time making the necessary changes in the wiring of the locomotive, provided such changes are possible.

However, if the d. c. trolley voltage is already 2,400 or 3,000 volts, increasing the trolley voltage would not be feasible, and it would be necessary to install additional copper or additional sub-stations.

Your Committee is not aware of any automatic sub-

stations being used in connection with steam road electrification, but as this type of sub-station is beyond the experimental stage, there being numerous installations that are operating satisfactorily, your Committee sees no reason why their use should not be seriously considered whenever the decision is made that the propelling power shall be direct current.

Their use would greatly decrease the amount chargeable for attendance, by eliminating the regular sub-station operators.

The impression, however, should not obtain that all labor charges are eliminated as these automatic sub-stations require regular inspection and testing by competent men.

Manually operated sub-stations may, of course, be located at terminals, in which case the operator could be used to perform other necessary work so that the attendance charge would be pro-rated.

However, if the location of the sub-station be such that three shifts of operators are required and the entire charge for attendance must be borne by the sub-station, the automatic type of sub-station would seem an attractive proposition.

In this connection an article entitled, "Automatic Sub-Station Experience in Cleveland," written by Mr. L. D. Bale, Superintendent of Sub-stations for the Cleveland Electric Railways, and appearing in the issues of March 3, 10 and 17, 1923, of the Electric Railway Journal, is very interesting.

Although the electrification of considerable new mileage in both Americas has been authorized during the past two years, i. e., since the last report of this Committee and a considerable number of locomotives and multiple unit cars have been ordered for these roads and for others already electrified, your Committee has not considered it desirable to tabulate the data for these extensions at the present time, but will content themselves by simply enumerating the roads which are authorized to be electrified. These roads are:

Chilean State Railways, Chili, South America, Valparaiso, Santiago, Los Andes, Los Vegas, 144 route miles, 3,000 volts d. c.

Paulista Railways, Brazil, South America, Campina, Jundiahy, 27 route miles, 3,000 volts d. c.

Detroit & Ironton, Michigan, U. S. A., 14 route miles, 22,000 volts, single phase, 25 cycles.

Virginian Railway, Roanoke, Va., Mullins, W. Va., U. S. A., 213 track miles, 11,000 volts, single phase, 25 cycles.

Respectfully submitted
COMMITTEE ON HEAVY ELECTRIC TRACTION.

Report of the Committee on the Application of Radio to Moving Trains

Description of Equipment Used, Results Accomplished and the Possibilities of Future Extension

Committee:—

P. S. Westcott, chairman, assistant car lighting engineer, Chicago, Milwaukee and St. Paul; F. J. Hill, chief electrician, Michigan Central; F. O. Marshall, assistant chief electrician, Pullman Company; S. D. Dimond, chief electrician, Minneapolis, St. Paul and Saulte Ste. Marie.

To THE MEMBERS:

The report of your committee, a committee which virtually constitutes a revival of the former committee of 1914, 1915, and 1916, ably led by Dr. Frederick H. Milliner of the Union Pacific in what apparently was a premature time but now made possible of revival by reason of the rapid advancement of the radio science, covers the subject in the main, as follows:

1. Applications relative to personal wants of passengers.
   A. Broadcast reception.
   B. Intercommunication between moving trains and fixed points for personal wire or phone service.
2. Applications relative to train movements.
   A. Dispatching.
   B. Automatic train control.
   C. Communication between locomotive and caboose of a freight train.

1 *Application relative to personal wants of passengers.*
A. *Broadcast reception.*

While broadcast reception is given most prominence in this paper it is only because it holds the biggest field of interest at the present time and because more is known concerning the actual demonstrated application of this phase of radio service. It is noted here that intercommunication holds more promise of real value in the future than the former, which has now begun to pass the fad stage and is settling into more stable form.

Broadcasting type of radio telephone transmission as differentiated from fixed transmission (service between two fixed points) may be defined as that type of transmission which is intended for consumption by an unlimited number of receiving stations. This, today may be classified as:

1. Government Broadcasting—Service broadcasted by the Federal Government.
2. Public Broadcasting—Educational and informational service by public and state institutions.
3. Private Broadcasting—News, entertainment, and other service broadcasted without charge by the station owner, who has most generally been a newspaper, or other private or public organization.
4. Toll Broadcasting—By a transmitting station of a public service corporation where a charge is made for the use of the station.

Radio broadcasting in present form, virtually grew over night. The art caught our lawmakers unprepared as there were no radio telephone laws, the present laws having been designed before radio telephone existed. Regulation of radio commerce in all countries is now conducted in accordance with the London International Radiotelegraphic Convention of July 5, 1912, and in the United States in particular, according to "an act to regu-

late radio communication" passed by Congress June 24, 1910, and amended August 13, 1912 and July 1, 1921. These laws have clearly been inadequate.

Radio has proven to be no exception to the rule that most developments are launched before they reach perfection and must be put to everyday test to bring out the shortcomings and master them. Manufacturers of bona fide equipment with experience back of them were unable at first to keep pace with the demand for equipment, which opened the way to adventurers in finance, with little or no experience, to step in and fill the deficiences in quantity with inferior quality. This applied to both transmitting apparatus as well as receptive apparatus and explains the unsatisfactory results obtained as to quality in the earlier stages of development when it is realized that no matter how fine a quality either transmitter or receiver is, if the other is inferior, poor results will be obtained.

Wave Lengths

To communicate by radio utilizes the method of signalling by wave motion. The necessary wave motion medium is, in this case, the ether, as yet an unknown something which pervades all matter in the universe. The waves are electric waves, more commonly designated as electromagnetic waves, and the position of the so-called radio waves in the electromagnetic wave spectrum is shown in Table 1. All these travel at the speed of light or 300,000,000 meters per second, which explains the relations shown between frequency and wave length.

TABLE 1.

Waves	Frequency (Kilccycles per sec.)	Wave Length (Meters)	Receiver
Gamma Rays as given off by radium, X-Rays, down to shortest Ultra-Violet Rays	30,000,000,000,000,000 3,000,000,000,000	.000,000,000,1 .000,000,638	Photographic plate or fluorescent screen
Violet to Red Light, the commonly known color spectrum	830,000,000,000 270,000,000,000	.000,000,36 .000,000,8	The eye
Infra-Red Rays, including what we know as heat	Down to 300,000,000	Down to .001	The skin
Radio waves.......	6,000 12.5	50.0 25,000.0	The aerial with suitable detector circuits

There are many more frequencies of ether electromagnetic wave motion which are apparently available to the radio science in various forms, but as yet we have not learned how to use them. The limits fixed in the table represent the present day range. As an example of other possibilities, in June 1922, Marconi demonstrated his directive radio before the Institute of Radio Engineers working at a wavelength of 1 meter (300,000 kc.) and spoke of having carried on radiotelephonic communication for nearly 100 miles at 15 meters (20,000 kc.)

This question of frequency is of greatest importance today since the types of generators capable of developing electromagnetic wave motion at radio frequencies, together with the detecting devices used, greatly limit the number of transmitting stations which may safely operate over this band of radio frequencies without interfering with each other. To offset then, this limitation caused by present day apparatus, it is necessary that adjacent transmitting stations must have a difference in frequency of at least 10 kc., which limits the number of stations that can operate in a given locality and still avoid interference.

In the past it has been the custom to differentiate radio wave motions in terms of wave length in meters when assigning an operating point in the radio wave scale to a station, but now that the question of interference is paramount, the term kilocycle (kc.) is to be used, the kilocycle assignment value representing the average frequency for the frequency band in question, such that the limits of the band extend to 5 kc. above and 5 kc. below the average. This is better understood when one notes that the amateur wave length assignment of 150 to 200 meters (2,000 to 1,500 kc.) allows 50 bands of 10 kc. each, whereas at a higher wave length say from 1000 to 1050 meters, also a difference of 50 meters (300 to 286 kc.) there is little more than one 10 kc. band.

Broadcasting Frequency Assignments

On Oct. 5, 1922, there were 546 broadcasting stations in the United States, all operating at 833 kc. (360 meters). When the Department of Commerce decided to limit all broadcasting to a single wave frequency, it is apparent that no one dreamed that so many people would want to broadcast. These 546 stations were by no means evenly distributed, and some districts, so overrun with transmitters operating at the same frequency, operated with a gentlemen's agreement such that each station was allotted certain periods of time in which to transmit its program. In this uproar, variety and quality were lost, and the station closest to the receiver or with greater power when at the same distance, won out.

At the request of the President, Secretary of Commerce Hoover then called a conference of representatives of all private and public, together with governmental interests, to devise means whereby the situation would be relieved. Their recommendations were expressed in their report before the House Committee in charge and the subsequent White Radio Bill HR 13773 of Jan. 11, 1923, the field covered by the bill being briefly summarized as follows:

1. The largest number of benefits derived from a systematized use of the ether.
2. The legal rights of revoking of operator or station licenses by the Bureau of Navigation.
3. The provision for the collecting of fees to more adequately maintain inspection service.
4. A fairer allocation of wave bands.
5. To make Federal regulations continuously effective.
6. The establishment of an advisory committee made up of representatives of Government departments and public interests to assist the Department of Commerce to provide unexpected changes for development in the use of the radiophone.

As a first step toward helping out the interference situation, some 40 of the best types of broadcasting stations designated as Class B stations, were moved out of the 833 kc. class and given another wave band frequency of their own at 750 kc. This did not relieve the situation much, and when the Senate failed to pass on the White Bill, new allocations were put into effect on May 15th which are at present in effect.

The broadcasting stations which are coming to be known as the BX stations, have now been variously assigned wave bands varying between the limits set by the internationally agreed frequency for marine and aircraft radiotelegraphy and within which band the majority of distress signals are sent, and that assigned for amateur work. Allowing then, a fair amount of leeway to minimize the chances of interference from these two older classes of service at the extremes of the available strip,

that is between 550 kc. and 1350 kc. (545 meters and 222 meters) some 80 noninterfering bands become available. In following the recommendations of the conference, the Department has distributed this assignment as follows:

Class A.—Includes the low-powered group with limited distance range. Assignment range 1050 to 1350 kc. (286 to 222 meters).

Class B.—Covers stations of 500 watts power or over, with strict requirements as to quality of program and transmission. Assignment range 550 to 1040 kc. (545 to 288 meters).

Class C.—Includes, for the present, stations that will use the old 833 kc. frequency which lies about in the center of a reserved range of 800 to 870 kc. (375 to 345 meters). These are stations whose management desire to continue to use the old 360 meter wave length, regardless of whether they use high or low power.

In distributing the wave bands for the higher grade Class B stations, the United States has been divided into five broadcasting zones, and each zone assigned 10 of the 50 bands at 10 kc. each available, such that the frequencies of adjacent stations within a zone are 50 kc. apart, and of stations in adjacent zones are at least 20 kc. apart.

In distributing the remaining bands available for Class A stations, these were distributed among the radio inspection districts, to be assigned on a basis that will keep stations using specific frequencies as far apart geographically as possible.

This then, has made great strides forward in reducing interference between stations to a minimum and is of immense value to the railroad which contemplates a receiving installation for the benefit of the travelling public for there is now much greater variety at much greater quality than was possible to attain by those who have experimented about the country prior to May 15, 1923.

Broadcasted Material Available

For railroad reception on a moving train, the source of broadcasted material is twofold; that available at large, and that available from a railroad owned broadcasting station. In pleasing the public, the following items must be considered:

1. Material available.
2. Grade of output of the transmitter.
3. Time of day the material is available.
4. Interference between stations transmitting.

When receiving from stations at large, the operator of the receiving unit has no control over the first two items. With respect to Item 3, it is necessary that the train carrying the installation be so selected as to receive greatest benefit, on account of time schedules of broadcasted programs and because of the fact that the daylight range is far less than that at night, being sometimes as low a ratio as of one to three. There is little control over this item, but under present day rulings, as previously noted, this has been well adjusted. There of course is interference from an unwanted station by reason of geographical location at the time, there being little opportunity to "tune out" this station when virtually under its shadow, when that station may have a consistent range of a distance of half way across the continent.

When receiving from a railroad owned transmitting station, there is quite positive control over all four of the items listed, the last being controlled by power output to quite a degree, which if sufficient, will lessen the possibility of local interference of another nature than between stations as will be noted later.

Attention is likewise called here, to the installations of the Atlanta and West Point Railway Company and the Delaware, Lackawana and Western Railway Company, and of the benefits derived and the field of possibilities opened by reason of the fact that each had company operated stations, in the form of emergency train dispatching and service to their passengers in the form of personal wire or information bulletins addressed to the radio equipped train by the broadcasting operators.

Installation

Briefly, the cycle of operating events surrounding the broadcasting by radiophone may be listed as follows:

1. The generation of alternating current at radio frequency, the wave form to be of constant amplitude, (known as continuous waves), the same to be electrically connected to the aerial (or antenna) in a manner to radiate energy in the form of electromagnetic waves (to be used as "carrier waves" for telephony).
2. The controlling (modulating) of the carrier wave by a modulating current at audio (audible) frequency, which in turn is controlled at a form of phone transmitter by sound waves.
3. The propagation in all directions of the electromagnetic waves in hemispherical form, which travel outward from the source at the speed of light.
4. The impinging of these electromagnetic waves, whose energy has diminished inversely as the square of the distance from the source, upon a receiving aerial (or antenna).
5. The tuning (resonating), by a combination of capacity and inductance, of the receiving circuit, such that an alternating current of the same type and frequency as that at the transmitting antenna, is caused to flow in the receiving circuits with maximum effect.
6. The "demodulating" or detection of the original voice frequencies as circulating in the modulation system at the transmitting station.
7. The activating of telephone receivers, loudspeaker or the like into giving off sound waves in duplicate of the original speech sounds which controlled the modulating system at the transmitter.

A knowledge of radio in general together with a survey of a number of installations already successfully operated, has been compiled into recommended specifications which any railroad would do well to consider before endeavoring to make such an application, thereby benefiting by the experiences of the pioneers.

Recommendations on Receiving Equipment

The Antenna System.—The wire network which is to be exposed to ether action as a collector of electromagnetic wave energy by the induction of an alternating current in the antenna circuit may be either of two general types; an external flat-topped antenna or indoor loop aerial. The advantages and disadvantages of each are listed.

1. External Antenna.
   Advantages—
   a. Greater reception distance available.
   b. Change in running direction of train makes little difference in volume as a rule.
   c. With more area exposed to ether wave action, requires less investment for sensitive receiving

apparatus within the car on account of more energy transferred as induced current, available for energizing the set.

Disadvantages—

a. Atmospheric disturbances are at their worst in this type when active.

b. External disturbances due to telegraph lines, high tension lines, faulty, sparking electrical machinery, etc., cause more or less trouble with this type.

c. More possibilities of interference between stations of like wave frequency by reason of a nearly nondirectional effect of this type.

Fig. 1. General View of Antenna Construction

2. Internal Loop Aerial.

Advantages—

a. Practically all elimination of atmospheric disturbances.

b. Practically all elimination of miscellaneous interference as of item 1-b above.

c. Assistance in picking out one station above the possible interference of other neighboring ones on account of the extreme directional effects of the loop along the plane of the coil.

Disadvantages—

a. Very much weakened signal strength on account of such slight area comparatively, which is exposed to electromagnetic wave action. This is especially true within a steel car.

b. Necessity of much more sensitive apparatus on account of very weak currents induced and consequent initial and upkeep expense.

c. Extreme directional effects, while useful in tuning out other stations to the advantage of the one, also adds the necessity of continual manipulation of the loop about its center to account for change in direction of motion of the train.

On account of the fact that it is impossible to date to overcome the disadvantages mentioned for the loop aerial, while it is on the other hand, possible to reduce to a great degree, the troubles encountered with the external type, and because when properly adjusted, the external type gives such excellent results, it is suggested that this be used in preference.

Fig. 1 shows a club car with external flat-topped inverted "L" type antenna installed. This is designated as inverted "L" since the horizontal lengths form the base of the "L" and the "lead-in" to the receiving set in the interior, when applied in normal fashion, in other than railway application, forms the vertical part of that letter. This type has been found preferable to a "T" type (lead-in at the center instead of at one end) and with two horizontal wires, one at either side (only one is seen in this view). The so-called cage antenna is composed of several wires in the horizontal part, usually from four to six, formed about hoop supports into an enlongated squirrel cage, with the ends of the cage wires brought to a conical terminus at the ends of the cage. The very slight advantage of this type over that recommended does not warrant its construction.

In Figures 2 and 3, the details of the antenna suspension are shown. In this case, the brackets were formed from bar iron 1½ inches wide by ¼ inch thick and formed into the three sections as shown, namely the two vertical supports and the top tie member bolted to the two supports with a ½-inch bolt at either side. The inside support is fastened to the side of the upper decking and the two vertical supports are each held in place by three large size wood screws. In this case the wooden cross partition within the interior was located and the screws driven down into it.

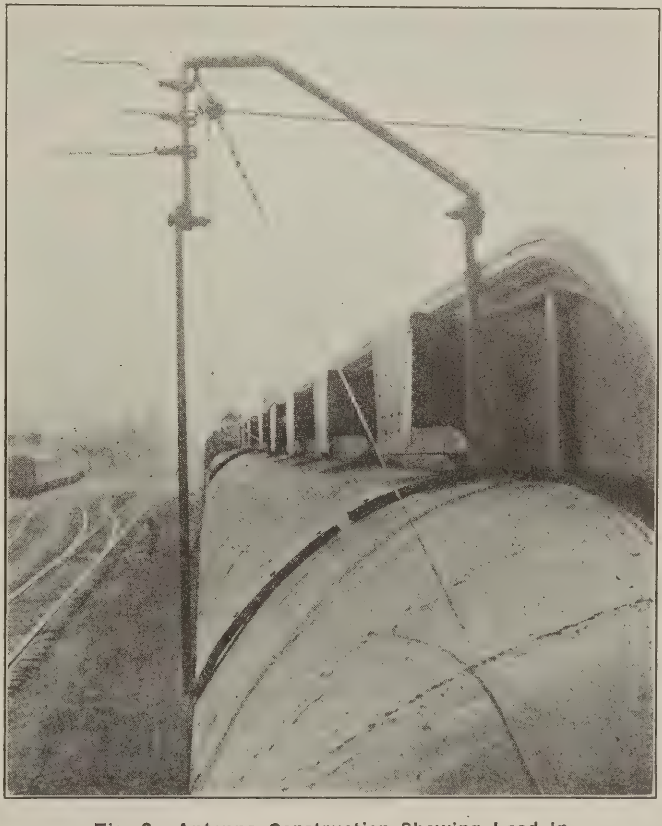


Fig. 2. Antenna Construction Showing Lead-In

Each car requires at least four brackets and if the sway proves to be too great, two intermediate brackets, one on either side can be installed provided that the antenna wire when supported by these is thoroughly insulated by an approved type of knob insulator.

At the top and center of Fig. 3 is clearly indicated the insulators segregating the active span from the iron bracket. The other inserted in the end guy is not es-

sential. For ordinary use this type of porcelain strain insulator is sufficient. If better insulation is deemed necessary by reason of rapid coating of carbon deposit, a higher potential strain insulator of formed rubber such as indicated in Fig. 4, may be used. This is particularly so in the case of transmission *from* a train. The latter should be periodically cleaned with alcohol to remove any current carrying coating. Antenna insulation is important as very weak alternating currents of extremely high frequency are being dealt with.

Referring again to Fig. 3, the cross tie electrically connecting the two single wires together, is indicated at the top and to the left. In addition, note the turnbuckle in the end guy to provide a ready means of taking up slack.

The question of clearance is paramount in this type of installation and in that connection note the three "feelers" of rubber covered copper twisted to the outside vertical supports and cut to varying lengths. These located additional side clearance over that allowed in clearance diagrams. You will note also that the top member of the bracket construction is so built that if accidentally hit, it will bend over with the two bolts as axes, without damage to the car roof. The only damage in such a

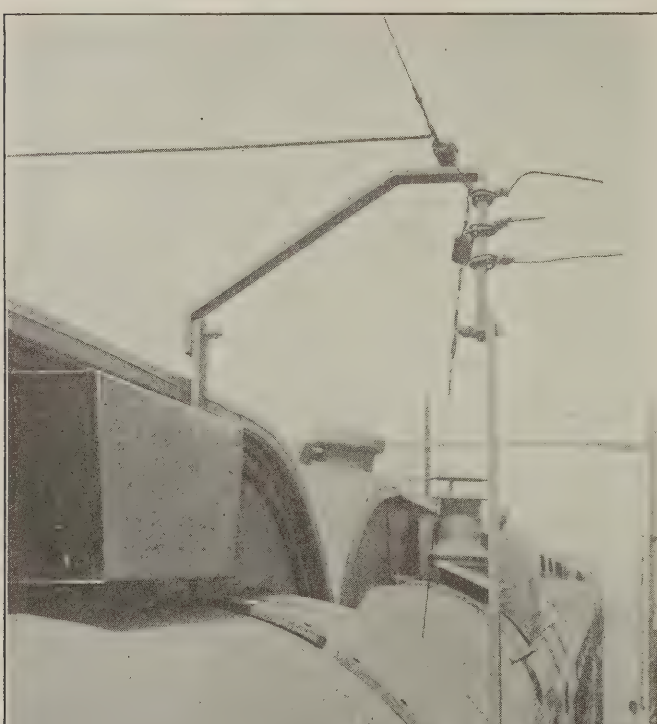


Fig. 3. Antenna Construction, Railway Receiving Equipment

case would be to one of the guys, which is quickly and easily replaced. It is well to carry extra wire, insulators, and turnbuckles along with the car for emergency.

For permanent installation, not only to properly insulate the lead-in from the metal parts of the car, but also as weather protection to the car roofing itself, a lead-in insulator such as shown in Fig. 5 should be used. A hole drilled to the size of the threaded portion through both outer roof of the lower deck and inner roof should be so located as to be adjacent to the end of the active horizontal wires and still convenient to bring the lead-in into the interior of the car. The round electrose nut, when drawn up on the cast threads of the insulator properly will hold the same in position.

The antenna wire (external) including guys, should be of 7 strands of No. 18 to 22 size copper cable or silicon or phosphor bronze cable. The lead-in should be No. 18 rubber covered or weatherproof wire.

Within the car, the lead-in will be carried along over some decorative moulding for appearances, to the receiving unit, which as noted later, is preferably located in the center of the car.

In completing the antenna circuit, it is necessary that

Fig. 4

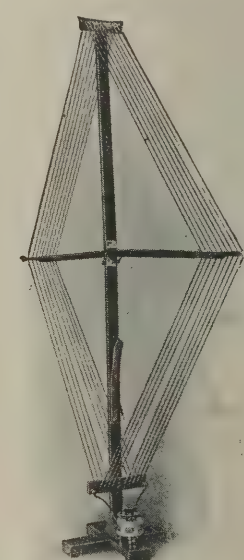


Fig. 5 Fig. 6

Fig. 4. High Potential Strain Insulator
Fig. 5. Lead-In Insulator
Fig. 6. Collapsible Loop Aerial

there be a ground connection, which may be made by leading some of the same type of wire as used for the antenna lead-in, from the set, along the floor to a convenient metallic point of contact with the car body. This contact should be as firm as possible, utilizing for instance, a heating or air pipe cleaned at the point of contact and drawing a ground clamp around the same.

It has been found by experiment, in cutting down minor interferences as from defective axle-generators, from faulty fan commutators, etc., that the use of a counterpoise antenna in addition, is preferable. A counterpoise antenna is normally used *in place of a ground connection* and consists of another insulated antenna but supported below the main antenna and just a small proportionate amount of the height of the main antenna above the ground. In this relation, the counterpoise acts as the other plate of the antenna system condenser of which the other member acts as the first, and is a substitute for the grounded type of installation where the ground itself acts as the second plate of this capacity. It is advisable then, that the ground lead be also connected to a counterpoise antenna, or better still, if by

trial it seems best, the counterpoise only be used for the grounded side of the receiver.

In placing a counterpoise, wires of the same kind as the roof antenna and insulated in the same manner should be strung along the length of the car and underneath. If insufficient room is found, one on each side, vertically below the car sides about four to six inches is used. More wires strung parallel to these first two and underneath the car body six inches to a foot farther in should be sufficient. As in the case of the roof antenna, these should be insulated at the ends, should be tied by a cross wire at the ends for electrical continuity, and at the same end of the car at which the roof antenna lead-in is tapped, a counterpoise tap should be led up into the car. No lead-in insulator is absolutely essential here, particularly if a ground to the car itself is used in addition. If

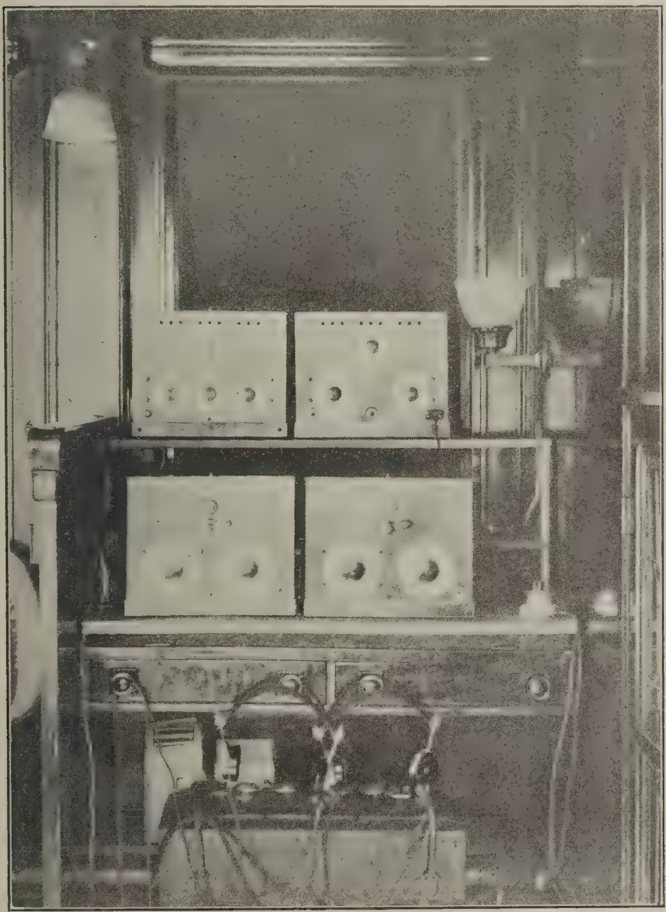


Fig. 7. Installation of Receiving Equipment

counterpoise only is used, it is advisable to insert another lead-in insulator in the floor of the car in a convenient place for leading in the counterpoise wire.

If a loop antenna is used within the interior of the car, no external antenna or ground wiring is necessary, the two terminals of the loop being connected directly to the antenna and ground terminals of the receiver. The loop should be so placed as to allow complete freedom of rotational control. Certain types on the market are built upon a box standard, on the front face of which is a dial, geared to the central vertical loop support in such a ratio as to allow quick manipulation for change in running direction, from the dial. Fig 6 shsows a Radio Corporation collapsible loop aerial.

It is well to note the hazard of operating an external antenna within an electrification zone of a steam line on account of the possibilities of a trolley wire dropping on to the antenna where trolley current collection is used, and severely injuring or possibly killing outright anyone in electrical contact with the parts of the set. In lieu of this condition, it is suggested that means be provided for short circuiting the roof antenna to the ground directly by the set during this period, and that an auxiliary loop be carried along as a part of the equipment, the set of course being wired so as to conveniently take either type of aerial at will. This type of operation would also hold true were station or atmospheric interferences too great

Fig. 8. Set Combining All Controls in One Cabinet

to overcome at any time, such as in the case of a local thunder storm during the summer months.

The Receiver.—The proper location of the receiver is important from both the standpoint of operation and also that of appearance.

On account of the severe jarring felt over the trucks, it has been found very desirable to locate the receiver as near to the center of the car as possible. This requires of course, that the antenna and ground leads (if an external type is used as recommended) be brought back a half a car length. This works out all right from an operating standpoint.

Fig. 7 illustrates an application to the writing desk of a club car. While satisfactory from a radio standpoint,

Fig. 9. Double Circuit Tuning Element or Variocoupler

with all controls within easy reach, the appearance is not such as blends with the high polish interior of our modern type of first class equipment. It is of course well understood that the most of the installations made to date, including the one represented in this figure, were experimental in nature but when it is noted that the two upper units of Fig. 7 have a very neat appearance when combined as they are in Fig. 8, it is seen that upon demand for railroad service, this item can and should be readily taken care of.

If the jar is still found to be severe at the center of

the car, care should be taken to cushion the whole set and see that the vacuum tubes within the set are cushioned at their sockets.

For best results, the tuning element should be of the double circuit type. While the details of construction may differ materially, Fig. 9 will illustrate the principal. The windings of the fixed coil or stator, are in series with the antenna-ground circuit of the external antenna type, and currents of the same frequency as those in the antenna circuit are induced magnetically in the secondary winding of the coupler which is designated as the rotor winding. Variations of coupling between primary and secondary do much toward careful tuning to the desired station to the elimination of others, which is of great importance.

A variable weathervane condenser, illustrated by Fig. 10, where the dielectric is air and movable vanes are caused to rotate within fixed ones, to regulate the overall capacity, is best inserted in series with the antenna lead of the primary circuit and another in shunt with the rotor of the secondary circuit both to act with their accompanying inductances that the inductive reactance is offset by an equal capacity reactance so that the impedance of the circuit may be made as small as the resistance and so neutralize the severe effects encountered with high frequency alternating currents and allow the

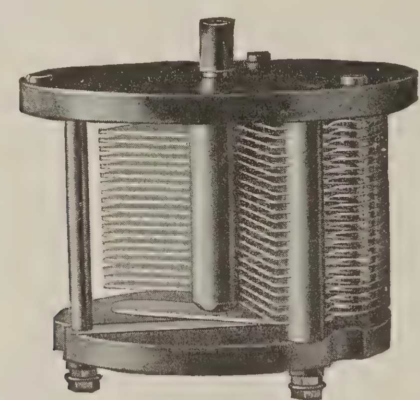


Fig. 10. Variable 43-Plate Condenser

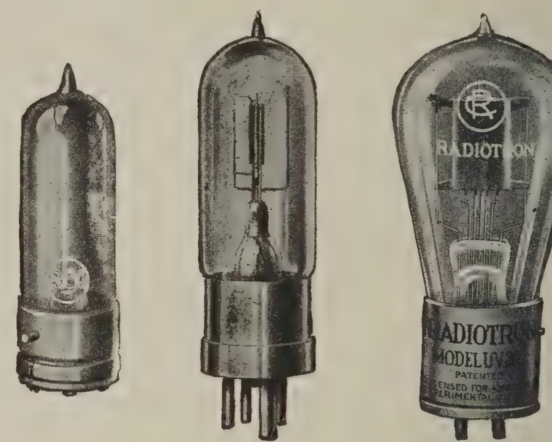
wanted frequency current to pass with only resistance to oppose the flow.

In the cycle of receiving operations it becomes necessary to rectify the high frequency currents and sort out the voice frequency in duplicate of that controlling the carrier at the broadcast station. In present day equipment, a vaccuum tube detector is used for this purpose. Fig. 11 shows some of those available today and Table 2 contains a more complete listing, showing the more important characteristics.

Unless sufficient current is originally induced at the antenna, the vacuum tube detector will not function. It has been found in the application of radio receivers to a moving train, on account of the varying types of countryside through which the train travels, on account of the close proximity of the roof antenna wires to the metal car which in turn is well grounded, and on account of the necessity of providing a margin of safety to allow operation through all reasonable interference, that amplification of the weak currents be accomplished prior to leading them into the detector tube.

Amplification of the sort mentioned is known as radio frequency amplification, or the building up of energy at radio frequency. Those tubes available as good radio frequency amplifiers are noted in Table 2. To all appearances detectors and amplifiers appear much alike and in fact their internal elements are virtually the same except for minor details which make one tube type more efficient as an amplifier than another.

At the present time, transformer coupling between the radio frequency amplifying tubes is most applicable, particularly when it is recommended that no less than three stages be employed. The limitations of transformer coupling are in the fact that these transformers cannot



A B C

Fig. 11-A. UV-199 or C-299
Fig. 11-B. WD-11 or WD-12
Fig. 11C. UV-200, UV-201A, UV-202, C-300, C-301-A, C-302

be made to operate over a very large band of frequencies at good efficiency. Some manufacturers furnish special mountings such that a set of transformers can be kept at hand and removals and replacements can be quickly made according to wave length. Another plan is to wind two distinct windings in the same casing and by throwing a connecting switch on the mounting, the same transformer can be made to double the range. However, with

Fig. 12. Power Amplifier and Loud Speaker Unit

the present allocation of wave bands and with the most of the service with the exception of governmental service within the range of one winding of radio frequency transformer, this trouble is practically eliminated for the present.

Under proper operating conditions and with moderate intensity of signals, the output of a detector tube is approximately proportional to the square of the input voltage but as a rule, the radio frequency serves best to

bring weak signals of distant stations or those weakened by antenna limitations, to the point where the detector can make use of them.

It becomes necessary then, to amplify the rectified currents at audible frequency such that more than one or two persons may have the enjoyment of reception. Audio frequency amplification is again accomplished by the aid of vacuum tubes, and coupling between tubes is nearly universally transformer coupling. Table 2 indicates those tubes which act best as audio frequency amplifier tubes.

of the Western Electric VT2 or 216-A, note the tubes inserted in the sockets in this photograph, which are the 216-A tubes, and which appear very much like the VT2 tubes.

Provided no great range is required, and the signals received are sufficient to operate the detector tube, what is known as regenerative amplification may be utilized. This might be termed self-amplification. In this circuit the detector is connected in such a manner to the tuning units that prior to rectification, part of the high frequency

TABLE 2—VACUUM TUBE DATA

Type	"A" filament voltage	"A" filament current	"B" plate voltage: Detector	"B" plate voltage: Amplifier	"B" plate voltage: Biased	"C" negative grid voltage for amplifier	Tube application: Detector	Tube application: Radio frequency amplifier	Tube application: Audio frequency amplifier	Tube application: Power amplifier	Filament material
UV 199 / C 299	3.0	0.06	20	40	60 to 80	1 to 4.5	Good	Good	Good	Fair	Thiorated
UV 200 / C 300	5.0	1.00	22½	..	......	....	Good	....	....	....	Tungsten
UV 201-A / C 301-A	5.0	0.25	45	60	to 100	3 to 6.0	Good	Fine	Fine	Good	Thiorated
UV 202 / C 302	8.0	2.35	40 to 60	100	to 500	3 to 9.0	Fair	....	Good	Good	Tungsten
WD-11 / WD-12	1.5	0.25	22½	45	to 60	1 to 3.0	Good	Good	Good	....	Coated
VT 1	2.5	0.90	22½	45	to 90	1 to 3.0	Good	Fair	Good	Fair	Coated
VT 2	7.0	1.35	45	45	to 350	1 to 40.0	Good	....	Good	Fine	Coated
216-A	6.0	1.35	45	45	to 150	1 to 12.0	Good	....	Good	Fine	Coated
RAC-3	4.0	0.80	22½	40	to 90	1 to 10.0	Good	Good	Good	....	Tungsten

Key—Prefix UV is General Electric make, distributed by Radio Corp.
Prefix WD is Westinghouse E. & Mfg. Co., distributed by Radio Corp.
Prefix C is General Electric make, distributed by E. T. Cunningham, of San Francisco.
Prefix VT and the 216-A made by Western Electric. The first two, the VT1 and VT2 are normally only available through government sales releases. The 216-A is sold with the 10-A power amplifier.
Prefix RAC is Radio Audion Co.

Owing to the fact that when amplifying at low audio frequencies, audio frequency amplifiers not only amplify the signal wanted but also the extraneous current variations caused by irregular electrochemical action in the batteries and by mechanical vibration of the tubes, the number of useful steps of "straight" audio amplification is best limited to two. If more energy is necessary for the operation of a loudspeaker or to supply energy to a long bus line for individual headphones, then it becomes

current is reimpressed on the detector, and the resulting re-enforcement causes louder signals.

The relative receptive value of this type of receiver as against that recommended is noted in Table 3 following, where actual results of tests are noted. Fig. 13 illustrates a type of set such as was used in tests made on the Delaware, Lackawanna and Western Railroad, and which utilizes regeneration, and includes two audio frequency amplification steps within the same container.

Fig. 13

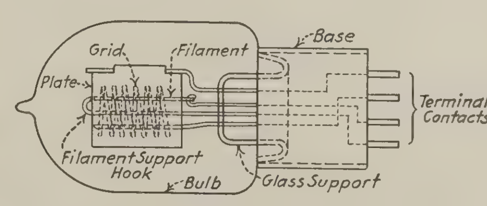


Fig. 14

Fig. 13. Set Similar to One Used in Tests on Lackawanna Railroad
Fig. 14. Sketch Showing the Elements of a Three Electrode Vacuum Tube

necessary to utilize a power amplifier which uses tubes capable of delivering much more power than is available from the ordinary receiving amplifier tube. Table 2 indicates which tubes act best as "power" tubes.

Fig. 12 illustrates the Western Electric Type 10-A power amplifier-loudspeaker unit, which is recommended as the best available, according to results obtained. The power amplifier unit can be used whether an individual headphone bus line is used or not. It serves admirably for both uses. In the absence of an individual illustration

In Fig. 14 is shown the elements of the three electrode vacuum tube. Briefly, the filament, when properly heated, gives off negative electrons, which are attracted to the plate by the insertion in the plate circuit of what is known as the "B" battery, with positive terminal connected to the plate, so that the unlike charges attract. The intermediate element, the grid, acts as a valve. When connected properly to the input circuit, receiving high frequency currents in the case of radio frequency amplification, or with the detector, and audio frequencies

TABLE 3—GENERAL DATA ON BROADCAST RECEIVER APPLICATIONS 1922-1923

Railroad	Train Numbers	Between	Conducted by	Duration	Operators	Antenna
Atlanta & West Point Railroad, including the Western Railway of Georgia and the Georgia Railway.	37 and 36.....	Atlanta, Ga., and Montgomery, Ala.	Railroad and NREC and others.	August, 1922, to date.	Experienced, NREC and amateurs.	External, inverted "L," 2 wires 60 ft. long.
Baltimore & Ohio................	57 and 58, 3 and 12.	Cincinnati, O., and Louisville, Ky.; also Cincinnati, O., and St. Louis, Mo.	Railroad and Crosley and Harmony.	April and May, 1923.	Experienced, Crosley and Harmony.	External "T," 1 wire car length.
Chicago & Northwestern.........	Wisconsin, Booster's Special, 1922.	Milwaukee, Wis., and throughout the state.	Special party and Julius Andrae & Sons Co., Milwaukee.	June, 1922, for about 5 days.	Party and JA&SC.	External "L," 2 wires 60 ft. long.
Chicago & Northwestern.........	Iowa's, 1923; Booster's Special.	Throughout the State of Iowa.	Special party and McGC.	May, 1923, for about 4 days.	Party and McGC.	External "L," 1 wire 2 car length.
Chicago, Milwaukee & St. Paul...	1 and 4........	Chicago, Ill., and Minneapolis, Minn.	Railroad and WE&MC.	April and May, 1922.	Railroad and WE&MC.	External "L," 2 wires 1 car length.
Chicago, Milwaukee & St. Paul...	1 and 4........	Chicago, Ill., and Minneapolis, Minn.	Railroad and WE&MC.	May and June, 1922.	Railroad and WE&MC.	External "L," 2 wires 1 car length.
Chicago, Milwaukee & St. Paul...	1 and 4........	Chicago, Ill., and Minneapolis, Minn.	Railroad and GEC.	April, May and June, 1922.	Railroad and GEC.	External "L," 2 wires 1 and 2 car lengths.
Chicago, Milwaukee & St. Paul...	Special movement.	Chicago to New Orleans, to Los Angeles, to Seattle and return.	Personal	March, 1923, for about 3 weeks.	Inexperienced, personal.	External "L," 2 wires 1 car length.
Chicago, Milwaukee & St. Paul...	Allis - Chalmers Special movement.	Kansas City to Milwaukee and return.	Special party and local West Bend, Kan., radio concern.	April, 1923, 5 days.	Party and radio company men.	External "L," 2 wires car length.
Delaware, Lackawanna & Western.	Various, including Cornell Special.	Hoboken to Morristown, Ithaca, and Scranton and return.	Railroad and various amateurs.	March, 1922, on.	Amateurs, experienced.	External "L," 1 wire 1 car length, 1 wire 2 car lengths, 3 six-wire 4½ in. cages.
Illinois Central	Private installation.	Various points through Illinois.	Private experiment.	May, 1922.....	Amateur, personal.	External "L," 3 wires 60 ft. long.
Louisville & Nashville............	3	Nashville, Tenn., and Evansville, Ind.	Railroad and NREC.	1923	NREC experienced.	Internal 2-ft. loop.
Milwaukee, St. Paul & Sault Ste. Marie.	Private installation.	Various	Private experiment.	1923	Amateur, personal.	Internal "L," about 40 ft. long.
Northwestern Pacific	Private installation.	Oakland, Cal., and Eureka, Cal.	Private experiment.	April, 1923....	Amateur, personal.	Connection to shell of berth lamp socket.
Southern	2	Washington, D. C., and Charlotte, N. C.	Railroad and NREC.	1923	NREC experienced.	Internal 2-ft. loop.
Wabash	1	St. Louis, Mo., and Kansas City, Kan.	Railroad and NREC.	1923	NREC experienced.	Internal 2-ft. loop.

Key to manufacturers and dealers:

Crosley ....The Crosley Manufacturing Company, Cincinnati, Ohio.
GEC ....General Electric Company, Schenectady, N. Y.
Harmony ....The Harmony Manufacturing Company, Cincinnati, Ohio.
JA&SC ....Julius Andrae & Sons Company, Milwaukee, Wis.
McGC ....The McGraw Company, Sioux City, Iowa.
NREC ....The National Radio Engineering Company, Atlanta, Ga.
WE&MC ....Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
FT&TC ....Federal Telephone & Telegraph Company.

when used with audio frequency amplification, is capable of performing the functions allotted to it with varying ability according to individual type construction. The general shape may be different than that of Fig. 14, and the materials used in the construction of the elements within the tube may differ, but the three elements and their functions are the same.

The current source for the filament is designated as the "A" battery. Columns 1 and 2 show voltage and current and the resulting wattage demand gives a relative value of the size of "A" battery necessary. All the tubes up to four volts potential at the filament can be operated on dry cells. All above require the current capacity available in a storage battery.

Tungsten filament may be burned at a bright white color. Oxide coated filaments should not be burned at a color greater than a bright red or orange. Thiorated filaments should be operated so that only a faint reddish glow is discernible. In all cases, care should be taken not to impress more than the rated voltage on the filament.

The three kinds of filament represent the development of the efficiency of the vacuum tube to date. The oxide coating was put on to increase electron emission and the same increased again by the application of the thiorated filament. Referring to a paper read before the Radio Club of America by Geo. E. Burghard, the improvement of the old UV-201 tube with tungsten filament

TABLE 3 (CONTINUED)—GENERAL DATA ON BROADCAST RECEIVER APPLICATIONS 1922-1923

Ground	Type of receiver	Loud-speaker	Location	Maximum good reception in miles: Phones	Maximum good reception in miles: Loud-speaker	Attitude of the passengers
To car frame and 2 to 4 wire counter-poise under body.	WE&MC Type RC.....	WE type 10-A power amplifier, with Audiophone.	End of car. End of train.	700	300	Very interested, especially in possibilities of railroad owned broadcasting station.
To car frame.....	Crosley Model X, Harmony Model 2.	WE type 10-A complete.	Center of car. End of train.	700	150	Very interested; prefer use of phones on account of extreme train noises, etc.
To car frame.....	Grebe CR-9	WE	End of car. End of train.	400	...	(Special movement.)
To car frame.....	WE&MC RT-AR-RA and DA set.	WE 10-A complete.	End of car. End of train.	400	...	(Special movement.)
To car frame.....	WE&MC type RC......	Magnavox R-3-B....	End of car. Center of train.	30	2 miles when train in station.	Unsatisfactory. Much interest, but only account of one of the first installations of its kind.
To car frame.....	WE&MC laboratory built.	WE&MC power amplifier and WE horns, 26 dictograph headphones.	Center of car. Center and end of train.	1,100	1,100	Very much interested. The individual phones much preferred; 26 pairs used.
To car frame.....	GEC then laboratory assembled, but similar to present Radiola VI plus AR-1,300 tuner and a built-up AR-1,300 modified.	GEC power amplifier, 2 Magnavox R-3-B.	Center of car. Center and end of train.	1,100	1,100	Very much interested. Train noises severe for loud-speaker service and annoying to those not interested.
To car frame.....	FT&TC type 60-55-56-9 set.	Atlas loud-speaker...	Center of car. End of train.	4,600 Hawaiian Islands to Hettinger, S. D.	800	(Special movement.) Type of loud-speaker limited that type of reception.
To car frame.....	Harmony Model 2......	WE 10-A complete.	End of car. Near end of train.	400	450	(Special movement.)
To car frame.....	Grebe CR-9...........	Magnavox R-3-B....	Middle of car. End of train.	1,000	600	(Special movements.) Later tests well received by passengers.
Two-wire counter-poise, 60 ft. long under car body.	Homemade (regenerative).	None	Rear of train......	1,100	...	(Private installation.)
None	NREC National Portable Railroad type.	WE 10-A with Bristol Audiophone Senior.	Rear of car. Rear of train.	1,000	600	Very much pleased.
To car frame.....	Radak regenerative.....	None	Center of car. End of train.	1,300	...	(Private installation.)
No ground	Flewelling (super-regenerative).	None	Center of car. Near end of train.	500	...	(Private installation.)
None	NREC National Portable Railroad type.	Type WE 10-A with Bristol Audiophone Senior.	Center of car. End of train.	1,000	...	Great interest. Weather conditions severe.
None	NREC National Portable Railroad type.	WE 10-A with Bristol Audiophone Senior.	Center of car. Center of train.	1,200	1,200	Very great interest. Various interferences along the way troublesome.

Key to apparatus:

	Tuner	Radio Freq.	Audio Freq.
Crosley Model X.............................	2 circuit	3 stages	2 stages
GEC AR-1,300 and Radiola VI.................	2 circuit	3 stages	2 stages
Harmony Model 2.............................	2 circuit	3 stages	2 stages
Grebe CR-9 (by JA&SC).......................	1 circuit	(regenerative)	2 stages
NREC RR. Portable...........................	2 circuit	3 stages	2 stages
WE&MC RC (RA plus DA).......................	2 circuit	(regenerative)	2 stages
WE&MC RT-AR-RA-DA	2 circuit	3 stages	2 stages
WE&MC Laboratory built for CM&StP.Ry.Co.....	2 circuit	3 stages	2 stages
Radak	2 circuit	(regenerative)	(Reflexed) Reflexed stages
FT&TC 60-55-56-9	2 circuit	3 stages	2 stages

and the same design but with thoriated filament is best shown as follows:

Type	Filament Volts	Filament Amperes	Watts	Electron Emission Milliamperes
UV-201	5	1.00	5.00	7.5
UV-201-A	5	0.25	1.25	45.0

In a study as to whether one desires to use a "dry cell tube," rather than a tube operated by storage battery supply, Mr. Burghard is again quoted as to dry cell life for a No. 6 size cell as follows, using UV-199 or C299 tubes:

No. of Tubes in the Set	Total Hours	(Use 2 hrs. of each 24 hrs.) Days	Months
1	387	193	6½
2	200	100	3⅓
3	126	63	2
4	92	46	1½

Under the caption of "B" Battery Voltage it is noted that there is a normal plate potential to use for detection, another for normal amplification and a third series higher than "normal" to which the plate voltage may safely be raised in endeavoring to attract the maximum number of electrons. The third values have reference to operation when a so-called bias or "C" battery is put in the grid circuit of the tube, negative terminal toward the grid. When properly adjusted the "C" battery will so regulate the tube that the extra potential can be applied to the plate as designated. This sort of operation applies to possibly the second step of audio frequency amplification or to a power amplifier step.

Because the storage battery tube is inherently a better

amplifier, it is recommended that where possible, a storage battery supply for the filament be used. If the radio equipped car makes an overnight run, it is best to arrange to circulate three storage batteries, keeping a freshly charged tray with the set at all times, and leaving a set at each of the two terminals for charging while the train is on the line.

For convenience, banks of flashlight batteries put up in "B" battery containers, are very desirable. However, an arrangement like that shown in Fig. 15 using the same operating schedule with three trays as above noted, is of immense help. The container of the type ACC-E34 Gould Unipower as illustrated, contains a six-volt storage unit of 60 ampere-hour capacity and a 120 volt bank of storage "B" battery, with arrangements self-contained, to charge the whole by means of an electrolytic rectifier for 110-volt 60-cycle current. Special sets are available for use with 25-cycle alternating currents and also for 110 volts or 32 volts direct current charging source.

The batteries, wherever located, should be as close to the set as possible to avoid line voltage drops. If a permanent installation, a cupboard should be built adjacent to the receiver stand.

Reference is made to Fig. 16 to illustrate the proper method of loudspeaker horn stallation. This is necessary to decrease the possibilities of diaphragm vibrations due

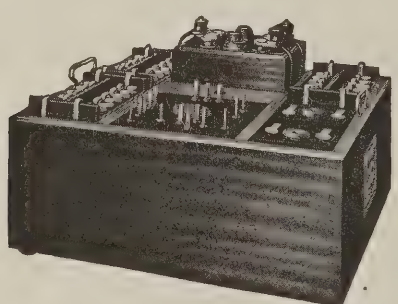


Fig. 15. Combination Case Containing Both "A" and "B" Batteries

to car vibration and also to place it above the heads of the passengers to allow sound transmission down the car.

In completing the equipment, at least two pairs of headphones should be available to the operator in charge, a spare set of vacuum tubes, and miscellaneous supplies should also be carried.

Figures 17 and 18 clearly show the type of supplies and equipment needed for such an installation as described. The big "B" battery block in the background of Fig. 18, is for the power amplifier unit.

Installations Costs

Item	Cost Estimate	
Antenna System, labor and materials	$27.00	
Loop Aerial	20.00	
Three type "C" Unipower "A" and "B" Storage Type ACC-E34	351.00	List
One receiving unit—Double circuit tuner, 3 radio, detector, 2 audio	250.00	List
One Western Electric Power Amplifier and Horn, Model 10-A (with tubes)	161.00	List
5 UV201-A amplifier tubes plus 2 spares	45.50	List
1 UV200 detector plus 1 spare	10.00	List
2 Headphones for operator in charge, Western Electric 1002-C	24.00	List
Miscellaneous wire and materials	10.00	
Labor for installation of set in the interior of the car	3.45	
FIRST TOTAL	$901.95	

This does not count discounts on list priced goods.

If it is desired to use individual headphones at each chair of an observation or club car rather than the loudspeaker, this estimate will be varied as follows:

Cost as above less loud speaker horn unit at $55.00	$846.95	
30 additional phones, Brandes matched tone "Superior"	240.00	List
10 Three-circuit jack mountings, Pacent Multi-Jack	15.00	List
SECOND TOTAL	$1,101.95	

In recommending sets available on the open market, to satisfy the demands above, the following makes are noted:

1. Radio Corporation, General Electric.
2. Radio Corporation, Westinghouse.
3. Federal Telephone and Telegraph.
4. Mu-Rad. (This is equipped with loop operation only and would require double circuit tuner in addition to meet requirements.)

Experimental Installations

In Table 3 are tabulated the results of a number of the more important tests on broadcast reception on a moving train which have taken place during the past year or two. The table is self-explanatory.

Fig. 16. Installation of Receiving Equipment Showing Location of Loud Speaker

Attitude of the Passengers

In every case recorded, great interest in the scheme has been shown by travelers. For the most part deficiencies where they were for the time being, virtually impossible of correction, were overlooked. However, using the wording of one informant, they were for the most part "interested but dissatisfied."

The reasons given for this attitude are listed, in general as:

1. Poor programs by lower grade transmitter of poor tone quality, etc. Since the recent reallocation of May 15, this has been remedied to a great extent by reason of more possibility of selection of type of program desired and stricter station license requirements by the government.
2. Inferior types of receivers of all kinds which were expected to act the same on a moving train as in a front parlor. This recommendation should help the status.
3. Distortion of loudspeaking equipment, jarred around by a train going at high speed, creating train noise impossible to overcome in that fashion. It was well demonstrated that the public desired individual headphone service since by that method, the occupant of the car who did not want to be disturbed need not apply a pair. Those who wished to enjoy the programs could materially reduce external train noises by the tight fitting of a pair of earphones, in which case the quality of the reception was much better by eliminating the loudspeaker, which has always been a source of trouble to one with a musical ear.
4. The many natural and man-made interfering waves due to track circuits, car lighting generators, high tension lines, etc. These have been overcome to a degree at present, having benefited by experience somewhat.

This brings up the question of operation. To properly care for the installation, an experienced operator should be put in charge, not only to properly care for the equipment but also to intelligently reply to the many inquiries as to the theory involved in the operation. This could well be an amateur of some experience, self-trained on account of personal interest in the art, who would very likely be pleased to have the opportunity of traveling about the country.

If this expense is not to be met with, then the next best possibility is operation by a company man of little or no experience probably, who would have to be trained to the proper way of operation.

As a third resort, it is possible to construct the set so that all tubes are properly lighted by ballast resistance control, similar in principle to that of the ballast lamp operation for the Electric Storage Battery axle-generator regulator. Further simplification of tuning elements, the locking up of batteries and of the cover to the set, would then allow the leaving of the set and one or two pairs of duly signed for headphones with any passenger who would enjoy being left to his own devices as to what should be received.

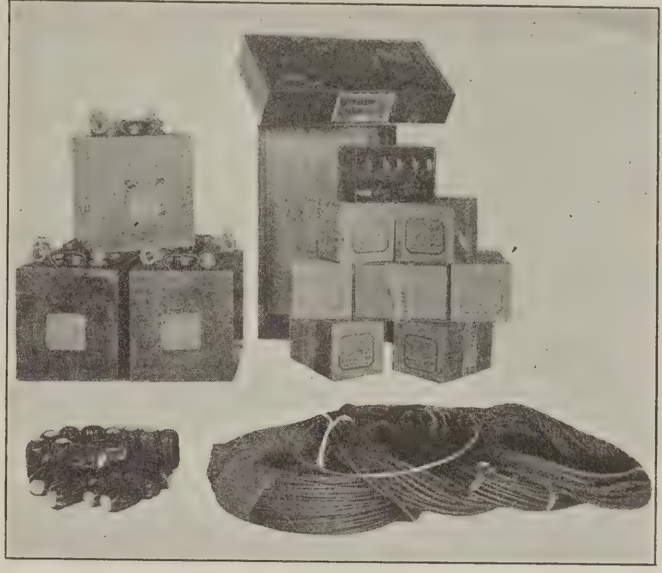


Fig. 18. Batteries, Insulators and Wire Used in Connection With Receiving Sets for Railroad Trains

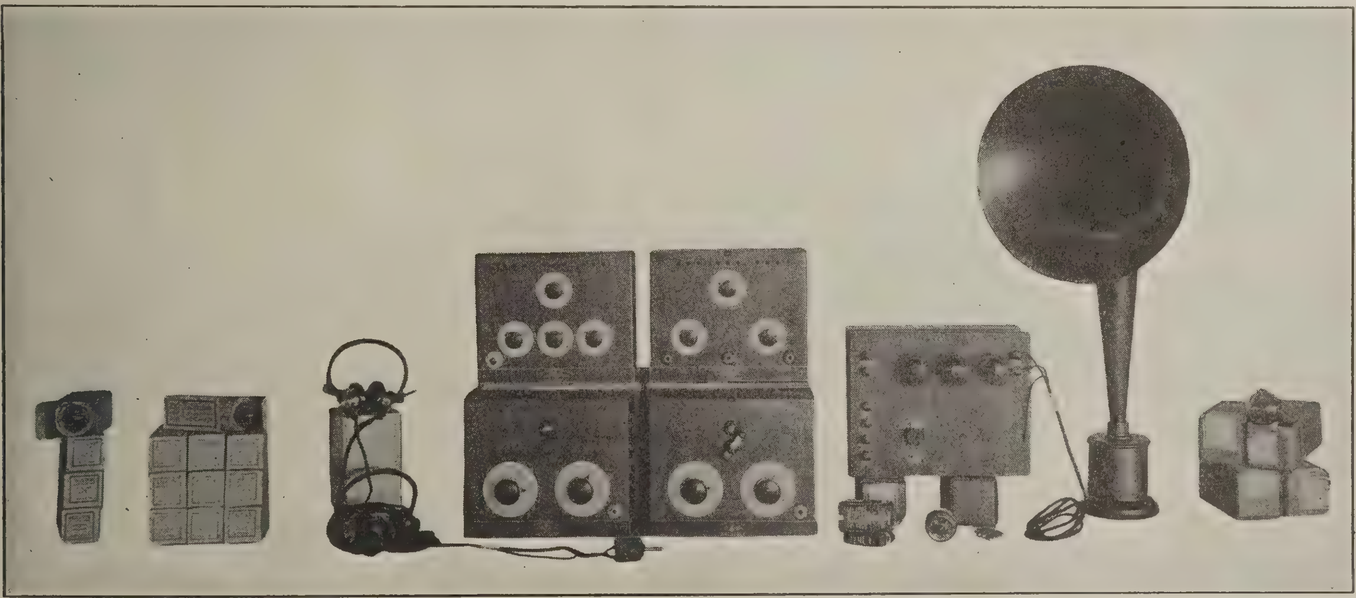


Fig. 17. Radio Receiving Equipment for Railroad Trains

Interference

Atmospherics.—There are two kinds of atmospherics, known as *static* and *strays*. The former, properly spoken of, is limited to electric charges carried to a receiving antenna by particles such as dust, smoke, moisture in the air, etc., which transfer their charges to it. If the an-

tenna is properly directly connected these charges will leak through the tuning circuit to ground without trouble. If a series condenser is present, however, these charges pile up on the plates to the point where they may spark across the condenser at intervals. The remedy is to use a condenser so well insulated that it will not spark across, or to connect a high resistance leak of about ¼ megohm across the condenser to keep it discharged.

The strays cause the most trouble. The clicking variety are directly attributed to nearby lightning disturbances and if too severe, can be practically eliminated by resorting to the use of the loop antenna in place of the external type until the period of extreme disturbance is over. The "grinder" variety is the worst type of the group, little being known about them at the present time. This offers most trouble with telegraph signals and it is fortunate that speech is carried through with more ease than the signals. The auxiliary loop must be resorted to for protection if these also prove too much to tune over.

Topographical Effects.—In some instances, the presence of hills between transmitter and receiver, produces a screening effect, either on account of absorption or because of reflection on the far side. A chain of mountains may produce a very complex shield. Forests absorb much energy. The effects produced while traveling through a tunnel seem to be relative to the character of the surrounding country and in some instances, the character was such as to allow perfect reception while several hundred feet beneath the surface. Lakes and swampy ground tend to strengthen signals. Throughout it all, there are certain localities where signals are received better than in others, and in some cases no signals can be received at all throughout certain wave bands. Interferences from this source are at present beyond control throughout the broadcasting bands of frequencies, and furnish a fertile field for investigation.

Works of man, external to the train.—Bridges, viaducts, trestles, and station sheds have a blanketing effect for the most part, except where there seems to be a considerable amount of moisture present in the immediate vicinity. The effects caused by all but the latter are only momentary as a rule, the train passing through the zone quickly.

Telephone and telegraph lines, alternating track circuits and high tension power transmission lines, when adjacent to the right-of-way, cause trouble. The telephone and telegraph lines must be extremely close to cause much effect, and the alternating current track circuits appear to cause interference of a troublesome quantity only at the ends of the signal blocks. Power transmission lines, however, if paralleling the right-of-way, reasonably close to the tracks, for any great distance, are of great interference, requiring complete shut-down of the receiver if not trapped out. Filters, constructed of a combination of inductances and capacities such that they reject all frequencies except those desired, may be placed in the antenna circuit when the external antenna is used, and some benefit derived. The use of a loop is recommended for such districts, however, the operator endeavoring to so swing the loop that the field from the transmission line gives minimum effect, and still hold as near a maximum signal as possible from the radio transmitter.

A faulty headlight generator on an adjacent locomotive will produce myriad frequencies of such variations that it is practically impossible to filter them all and still retain the high frequency currents desired, in sufficient quantity to operate the set. Discontinuance of operation until the car is away from the vicinity of the locomotive, or the use of a loop must be resorted to.

Stack gases blown across the wires of the external antenna, especially when passing at high speed, will produce static disturbances, which can be taken care of in the same manner as already described under the heading of atmospherics.

Works of man within the train unit.—Interferences from stray frequencies caused by faulty electrical machinery such as ventilating fans, car lighting axle-generators or head-end turbine generators, or from the headlight machine on the locomotive of the same train, with the aid of the line of steel of the train construction, will all cause serious interferences. These must be located at the source, placing capacity of sufficient amount across the terminals, to absorb the charges together with a choke of a few turns of wire of current carrying capacity in each line in series, as well, until the troublesome frequencies are trapped out.

Railroad Owned Broadcasting Stations

The benefits derived from the use of a railroad owned broadcasting station have already been noted.

In drawing up specifications for proper installation, the items to be considered should include:

1. Transmitter. Location, range desired, type, power sources.
2. Antenna. Location, type, counterpoise use if possible.
3. Compliance with Government Laws and International Laws. Station and operator licenses, other regulations.
4. Costs. Installation, upkeep, operators.
5. Service to passengers. Programs, bulletin to the train, emergency orders to train crew or passengers.
6. Intercommunication between moving trains and fixed points for personal service.

Telegraph

Telegraphic communication may be carried on by means of:

- a. Space Radio.
- b. Line Radio.

In utilizing space radio, it is noted that the advantages and disadvantages are as follows:

1. Advantages.
   - a. Requiring no wires other than antenna construction, guarantees operation for the greatest part of the time, limitations being only on account of atmospheric disturbances which are rapidly being overcome, or from other transmitters, which is somewhat overcome by proper allocations of wave bands, by geographical location.
   - b. By reason of its character, signals are sent in all directions, such that a fixed station, without alteration, is able to reach other fixed stations or moving trains variously located geographically from it.
2. Disadvantages.
   - a. No secrecy when hand operation by the required continental code is used.

b. Definite requirements to be met relative to radio communication laws as to licenses, operators, time of transmission, etc., that at present may apply to other than those directly relative to train communication conditions.

c. Atmospheric and inter-station interference as noted in I (transmitter).

d. Locality interferences as noted under the section on interferences for broadcast reception.

In utilizing line radio, it is noted that the advantages and disadvantages are:

1. Advantages.

a. Freedom from space radio regulation. There is no line radio supervision at present, so long as the high frequency currents do not radiate seriously from the line.

b. Secrecy, external to any connection made with the line used as carrier wire for high frequency currents.

c. No atmospheric or interstational interferences, with respect to space radio stations.

2. Disadvantages.

a. Possibility of the severing of the wire link by storms or other agencies.

b. Limited range of wave bands which can be used without radiating of an interfering nature to space radio stations, from the line.

In space radio, if automatic transmission and reception is utilized, the operator must still be able to handle the work of the radio telegraph man, which would not of course be so with wire radio. Relative to normal operation, the speed of operation and hence the amount of traffic in and out of a single station is markedly increased, and the accuracy is of course normally beyond dispute. A page printer type of machine such as the Teletype, put out by the Morkrum Company of Chicago, operating at 60 words a minute and upwards, would be a valuable adjunct. The Navy Department successfully carried on communication for several hours between Washington, D. C., and San Diego, Cal., applying a Teletype set to radio.

To use the Teletype, the degree of secrecy in space radio is much greater since the driving mechanisms at both transmitting stations, and receiving stations must be synchronized, and in tuning, the radio frequency must be tuned to resonance of course, and the audio frequency at the relay, inserted for operation of the printer, as well.

If messages from points at large, off the railroad lines, are to be reached, the incoming or outgoing messages at the terminal fixed station would be relayed to the outside wire lines.

In utilizing line radio, the following methods for line use are suggested:

a. The use of telegraph wires along the right of way. This has been proven decidedly possible by experiment. This is hardly possible except on roads where the greatest part of the trackage and wire lines parallel. In mountainous country, where the wire lines are continually following the contour of the country regardless of cuts and fills, and the use of tunnels, this would not be practical for linkage to a moving train on account of the train continually varying position to the point of being outside of the field of the wire lines. This of course would not apply to fixed station operation.

b. The use of the rails. This is a possibility but due to the nearness of the ground, and because of the varying effects of dry and moist ground and other agencies, the losses over very great distances would probably be great. For high frequency paths across track signal circuits at insulated joints, connections would be made with capacities for direct current or alternating current circuits.

c. The stringing of an iron or copper wire a little off the ground and parallel to the operating mains. This would give the most ideal operation. A variation between train antenna and this type of line would only take place at an occasional switch, and in the thick of crossings and sidings of a city or town. In such a case, the train would be passing rapidly by such a point to clear operation again or come to a stop, where communication at the station is at once established.

d. The use of the trolley or third rail as used for electrification. The practicability of the former has been experimentally demonstrated over trolley wires at 600 and 300 volt potentials, capacitive coupling being used for the radio link.

Telephone

The same limitations as to operation apply to telephony as well as to telegraphy as have just been noted. In addition the study of voice modulation control enters into the problem.

With respect to space radio operation, the degree of secrecy is practically nil, unless a complicated method of "frequency on frequency" transmission, requiring several steps to detune for detection to audio frequency once more is utilized.

To supply external connections to phone lines, requires relaying by the operator in charge, at the terminal stations, or the connecting electrically to the phone lines.

Applications Relative to Train Movements

a. Dispatching.—Insofar as this relates to dispatching to a moving train, and to apparatus on that train, dispatching comes within the scope of the work that should be carried on by a committee of this Association. Maintenance of fixed stations should, of course, come under the supervision of the telegraph and telephone engineer. Any supplementary equipment for line radio, along the right-of-way, should be maintained by the signal engineer. This would also apply for applications relative to personal wants of passengers as the system employed would not be distinctive but only a special use to which the system was put.

This service would be maintained to the trains by the three methods already noted; bulletins to the train from a broadcasting station, company owned, telegraph communication by space or line radio, and telephone communication by space or line radio.

b. Automatic Train Control.—Utilizing line radio, this has been tried out to some degree in Germany. When it is realized that an airplane has been maneuvered for hours through the air and brought safely back to rest and all by radio control in space, automatic train control by space radio or line radio appears only as a special application.

c. Communication between Locomotive and Caboose of a Freight Train.—Because of the present available

method of signaling the engine crew while in motion by air whistle, in the case of passenger service, freight service only is specified. The need here, with extremely long trains, operating in bad weather or mountainous country, is evident.

In making a thorough study of this application, these items are suggestive:

a. Communication from the rear of the train to the locomotive cab is essential, and two way communication is preferable.

b. Communication by signals will relieve the situation immensely, but to develop telephone communication equipment is very desirable.

c. The sets should be portable if possible, on account of the maintenance problems encountered in the way of tube renewals, the testing of tuning, battery renewals, etc.

d. Connection may be made to antenna already strung permanently on locomotives and caboose cars and tuning maintained by resonance control indicator in the form of a small flashlight lamp wavemeter included with the set, such that, when in resonance to the proper wave length, the lamp will be inductively lighted. For most flexible application, the loop transmitter-receiver is preferable, the directional properties being of use as well as the compactness of the whole.

e. A frequency below that so far assigned to any space radio service is preferable on account of less interference, more frequency bands in case of two-way communication, and the freedom from some of the existing laws relative to radio communication designed for the crowded groupings of wave allocations.

f. The development of a call system by howling or by bell or buzzer, to call the fireman's attention to the phone set. The most practical application would allow for a transferral to headphones at that stage in the operations, to insure good reception by cutting down on external interference from engine noises if headphones were not used.

Conclusion

In conclusion it is recommended that, on account of the great degree of experimentation through which these special applications of radio to a moving train are passing, with perhaps the exception of broadcast reception, although this has not reached a finished state, that the Committee be continued, and authorized to follow more particularly through in greater detail, the problems as presented. In every case there is much yet to be learned, and only by keeping in touch with the very rapid development of the art of radio can the Association hope to make use of it with respect to application to moving trains.

The committee wishes to acknowledge the assistance rendered by the many parties interested in radio who have furnished detailed information concerning this application of radio, and more particularly to the General Electric Company through Messrs. J. H. Clough of Schenectady and C. Dorticos of Chicago, to the Westinghouse Electric and Mfg. Co. through Mr. L. W. Chubb of East Pittsburgh, to Mr. P. G. Parker of the Chicago office of the Radio Corporation, to Mr. C. L. Kluge of Julius Andrae & Son Co., Milwaukee, and Mr. Bert Hall of the Commonwealth Edison Company Electric Shops, Chicago.

Respectfully submitted,

THE COMMITTEE ON THE APPLICATION OF RADIO TO MOVING TRAINS

Report of Committee on Locomotive Headlights

Status of Marker and Classification Lights With Regard to Operating Rules. Photometry Tests for Headlight Reflectors Recommended

Committee:—

L. C. Muelheim, chairman, chief headlight inspector, Baltimore & Ohio Railroad; J. L. Minick, assistant engineer, Pennsylvania System; E. W. Jansen, electrical engineer, Illinois Central Railroad; F. J. Hill, chief electrician, Michigan Central Railroad; E. Wanamaker, electrical engineer, Chicago, Rock Island & Pacific Railroad.

TO THE MEMBERS:

Your Committee was instructed to continue work in conjunction with the Headlight Committee of the American Railway Association; to consider a standard method of making photometric tests of headlight reflectors; consider interchangeability of glass reflectors and cast metal cases; consider alternating current headlight generators and developments in this field and to confer and work with the Committee on Automatic Train Control on the subject of power required for this feature, etc.

Regarding joint work with the A. R. A. Headlight Committee, a meeting was arranged for Sub-Committees of the two main Committees with the Committee on Operating Rules of the Operating Division of the A. R. A. to discuss possible changes in the operating rules made necessary by the introduction of electric headlights, classification and marker lights into steam locomotive service; also the character of construction required in the application of these devices to meet existing rules.

Discussion of the following specific questions was had on the subject of classification and marker lamps and their relation to Standard Code Rules Nos. 19, 20, 21 and 22:

(a) May electric classification and marker lights be permanently attached to locomotives and tenders?

It was the opinion of the Sub-Committee, Committee on Operating Rules, that this method of application is not prohibited by the rules.

The above question affects the design and location of the signal lamps, and it was desired, if consistent, to provide marker lamps fastened permanently to the tender but without a lens toward the front of the engine, as it was felt that the view of that portion of the lamp was cut off for a considerable portion of the time as a result of coal being piled high on the tender. It was further observed that under present conditions marker lamps on tenders in many instances were located on the rear end in such position as to be obscured from the view of the engine crew in the cab, although the rules require that the lamps be so placed that a man in the cab might have an unobstructed view to determine whether or not the lamps are properly lighted. It was suggested that per-

haps a double-deck type of lamp might be desirable, such a lamp having an advantage of costing less than a lamp that required to be turned in changing the signal indication.

(b) Where and how should classification and marker lights be applied?

It was the opinion of the Sub-Committee, Committee on Operating Rules, that they should be placed in the same relative position as now required by the book of rules. They felt that they had no jurisdiction as to exact locations, methods of attachment, etc., but expressed the opinion that classification lights on the front of the locomotive should be placed in accordance with the diagrams in the book of rules, and should be so mounted that the flat surface of the front lens is flush with, or in front of the flat surface of the smoke box or "front end." Also that the markers at the rear of the tender should be mounted on the top thereof and with the curved surface of the lens flush with the vertical building line of the side of the tender. In view of the fact that the application of electric marker lights to passenger equipment cars would probably come up for consideration in the near future, it was the opinion of the Sub-Committee on Operating Rules that definite decisions should be delayed, except as above stated, until full consideration could be given to both classes of service.

It was pointed out to the Rules Committee that it is desired, if possible, to have the classification lamps so placed on the front of the locomotive that they would permit removal of the front end of the boiler without disturbing the lamp fixtures. The necessity for having the lamps so placed that the light from both could be readily seen from a position in front of and to one side of the locomotive was also explained.

The question was also raised as to whether or not classification and marker lamps on the front of a locomotive could be interchangeable. The Rules Committee stated that this was not prohibited if the requirements of the operating rules were complied with.

(c) Should classification and marker lamps be fitted with two, three or four lenses?

The Train Rules now require two lenses for classification lamps and four for marker lamps. Owing to the gradual increase in the size of locomotive tenders, and with coal piled high, as previously referred to, the front lenses of the markers on the tenders cannot be seen from the cab of the locomotive, and they therefore serve no useful purpose. It was felt, however, that the omission of this lens should be held in abeyance until consideration could be given to both locomotive and passenger equipment car service.

(d) What size lens should be used?

The Sub-Committee, Committee on Operating Rules, felt that they had no jurisdiction in this matter. The object, it was stated, should be to use a lens of any size that would insure the necessary range of light. The question, however, it was stated, should be studied by a joint committee of the Mechanical Division and the Committee on Operating Rules with a view to standardizing lens sizes.

Discussion of the above question brought out that seome roads are now contemplating the use of lenses which may, in time, prove too small, but that the majority of the lenses now in use are of diameters between 5 inches and 5½ inches which size appears to be satisfactory.

(e) Does the introduction of electric headlights, classification and marker lights make it necessary to modify existing rules, and, if so, what rules will be changed and how?

It was the opinion of the Sub-Committee, Committee on Operating Rules, that no additional new rules are required, or that existing rules require modification. The Book of Rules is now being revised, however, and if any additions or changes are required that are not now anticipated, such changes will be made and the Committees concerned will be advised through the usual channels. In this connection the rules relating to the use of dimmers as a part of the headlight equipment have already been arranged for and which rules as amended and adopted at a session of the A. R. A. held at New York on November 16th 1921, read as follows:

"When rules require the headlight to be displayed, electric headlights on engines will be dimmed:

(a) In yards where yard engines are employed.

(b) At meeting points.

(c) Approaching stations at which stops are to be made, or where trains are receiving or discharging passengers.

(d) When standing.

(e) On two or more tracks when approaching trains running in the opposite direction.

Note—Railroads may add such further regulations as may be necessary to suit local requirements."

The Train Rules Committee suggested that plans and specifications be drawn up from the standpoint of the Mechanical Division covering the installation of classification and marker lamps and have such plans submitted to them for such suggestions or changes as they might have to offer. Accordingly a drawing was prepared showing proposed locations of the lamps to conform to the ideas expressed, and this was submitted for approval of the Train Rules Committee. The matter remains open at this time, however, as your Committee has not as yet received advice as to any action being taken toward approval of the arrangement.

Photometry of Headlight Reflectors

The Locomotive Headlight Law, unfortunately, specifies the efficiency required of the headlights in terms of pick-up distance—which is more or less indefinite—rather than in terms of beam candle power, which can be measured with reasonable accuracy. In the absence of something concrete on which to base the initial efficiency of a reflector to meet the requirements there has existed a sort of general understanding that when used with a standard headlight lamp a reflector should be capable of producing an initial efficiency of at least 500,000 beam candle power to be satisfactory under general service conditions. This, therefore, has been a sort of guide for the manufacturers in the development of the glass reflector and the desired state of its refinement to insure its meeting the requirements.

In testing reflectors the photometering method is used, and, while both metal and glass types are tested by the same method, the development of the latter type and the competition in this field has been the incentive for a great deal more of this work than formerly was the case with the metal reflector in general use. The present various methods of photometering are causing more or less confusion to those interested in a comparison of reflector tests, and we are considerably at sea when attempting to

compare the results of one testing laboratory with those of another. This confusion, it appears, is due principally to the different methods used to accomplish the same result. For instance, various photometric distances are used. One laboratory may test for maximum beam candle power and another for parallel beam. Also, with the variation found in the characteristics of test lamps even after being standardized, and despite the usually uniform filament construction the beam candle power values are greatly influenced by the characteristics of the lamp used. All of which has the effect of confusing the results of tests and making it difficult to arrive at a basis upon which intercomparisons could be easily and accurately made. It is very desirable, therefore, that some standard method be set up that could be used by all concerned or interested in the photometry of reflectors, and the use of which would enable anyone to intelligently and conveniently make comparison of any two or more tests—which cannot now be satisfactorily done under the varying methods employed.

With this in view your Committee has outlined in the following a general method which is suggested to form the basis of a standard detailed method that it is hoped may ultimately be established. While certain details in the suggested plan might be varied to suit conditions the basic features, it is felt, should be followed for general practice:

A suitable room should be provided, with dark, non-reflecting walls, provision being made for mounting the headlight reflector on a rotating table with its circumference graduated into degrees and so arranged that readings of approximately 3 minutes of arc may be obtained. The lamp support should be provided with necessary adjustments to secure fine focus of the test lamp.

The photometric distance should be 50 feet and focusing should be adjusted for maximum beam intensity at this distance. At the 50 foot station a dull, dark focusing screen should be placed having its surface ruled off with a vertical and horizontal reference line to facilitate proper focusing and adjustment. At the intersection of these lines an opening should be provided through which the test plate of the photometer may project. Additional curtains may, if necessary, be hung between the reflector table and the photometer to cut off any stray light that might be reflected from the walls onto the photometer test plate. Tests, therefore, may be made either at night or during the day, as no appreciable difference in results will be noted.

A direct illuminated photometer should be used and suitable switches should be provided for turning the current on and off.

Test lamps should be carefully selected to secure those in which the quality of workmanship is highest, filament construction most uniform and from electrical tests those that most closely approach rated values of voltage and current. These lamps should then be standardized at their rated lumen output for volts, amperes and mean horizontal candle power. Each photometric observer should calibrate his own lamps and a record card should be kept for each standardized lamp, giving its constants and having notation made thereon as to the hours of use. When such a lamp has been burned 15 or 20 hours it should be re-standardized. Light distribution tests should be made across a minimum of four beam diameters and the average of these tests taken as final for the given lamp and reflector.

Considerable difficulty is experienced at present in securing suitable test lamps, and although great care may be used in selecting lamps having a uniform appearance and electrical values close to normal, as well as being standardized at rated lumen output, considerable variation is noted in the standardized values of volts, amperes and mean horizontal candle power between the lamps of any one lot standardized. Due to these variations, therefore, values of beam candle power on a range test with a given reflector, as mentioned before, are more or less influenced by the characteristics of the lamp used. The difficulties experienced as a result of this variation could be very materially lessened, if not overcome entirely, if the lamp companies could be induced to build standardized headlight test lamps which would be available to all those interested in headlight testing. Such lamps it would seem might readily be built to certain predetermined standards, particularly with respect to filament dimensions and mean horizontal candle power at rated lumen output, and once available would tend toward much higher accuracy in such test work than is now possible.

It is further suggested that if it were possible for all those interested in locomotive headlight testing to agree to use some certain single cell filament low voltage lamp, built to certain standards, in all tests, it would tend to greatly increase the accuracy with which this work might be conducted. It would provide the means through which the characteristics of different reflectors might accurately be compared, and by means of reduction factors which could readily be arrived at such tests might easily and accurately be brought to a basis most commonly used at the present time, viz., a test made with a standard locomotive headlight lamp at a photometric distance of 50 feet. This practice is now being followed with entire satisfaction, although to a limited extent, by certain testing laboratories, where it is desired to compare reflectors relatively or qualitatively one with another. A low voltage single coil filament lamp is employed, generally such as is used in automobile headlights. This lamp enables extremely close focusing, eliminates almost entirely the troubles caused by filament images and permits of highly accurate photometric measurements. These test lamps are standardized against tests with standard headlight lamps focused for 50 foot testing and by means of reduction factors so obtained the operators are enabled to rapidly and accurately test reflectors with the low voltage lamps and by means of these reduction factors reduce the readings to the basis of 50 foot tests made with standard headlight lamps.

Interchangeability of Glass Reflectors

The dimensioning of glass reflectors has received some consideration with a view to development of a reflector that can be made to interchange with any make for any equivalent size of headlight case. Your Committee feels that the dimensions of a glass reflector should be taken from the same points of origin as those for a metal reflector wherein the reflector surface is the front of the reflector, whereas the reflecting surface of the glass type is the back surface which involves thickness of glass, refraction, etc. Figures 1 and 2 illustrate the development of a glass reflector on this basis.

The construction of the path of a light ray through a glass parabolic reflector will be seen in Fig. 1. The ray from the focus, incident upon the front surface of the

reflector at P is refracted and its direction is changed in such manner that $\frac{AB}{n} = A^1 B^1$ where n is the index of refraction for the glass used. A and A^1 lie on an arc struck with P as a center, and B and B^1 lie on the normal to the front surface at P.

It will be noted that the rays OP and IP' produced intersect at E. The focus of the point E has been termed the equivalent parabola. Its properties are such that a metallic reflecting surface through all points E, will exactly duplicate optically the performance of the glass reflector from which E was determined. In general E lies on the back surface only at the apex of the reflector, and gradually approaches the front surface, but is coincident with the front surface only at infinity. It is this equivalent curve to which the optical properties of the reflector should be referred. The effective reflector diameter is thus seen to be the inside diameter since the diameter to E and P^1 are seen to be identical. The focal length is measured to the back surface of the reflector, however, since E coincides with the back surface at the apex. This method for dimensioning reflectors coincides exactly with established custom in the case of the metal reflectors, where rated diameters, focal length and depth were located from the effective reflecting surface to which E corresponds. The effective reflector depth may vary somewhat in various designs due to difference in glass thickness and contour of the glass surface, but these differences are relatively small.

In Fig. 2 it will be seen that in consideration of the

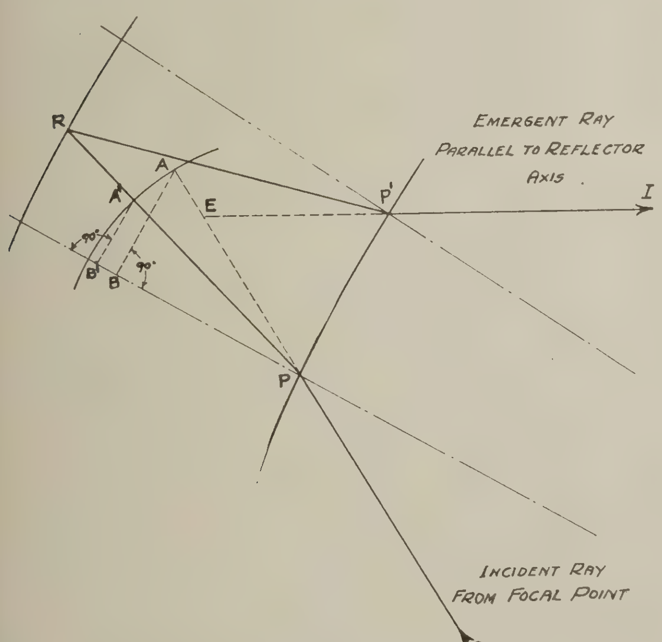


Fig. 1. Construction of the Path of a Light Ray Through a Glass Parabolic Reflector

foregoing the important optical dimensions are "A" and "C". "A" is the effective reflector diameter. A tolerance of $\pm$ 1/16 in. is considered as suitable in consideration of the best present glass working practice. "C" is a focal length dimension referring to the edge of the reflector which is readily available as a measuring or locating surface. This avoids the difficulty of measuring from a point in space where the apex of the reflector would be located were there no hole in the reflector.

"B" is the maximum outside diameter, and is specified for mechanical purposes only in order that the reflector may properly fit the shield and retainer provided. This dimension "B" may be specified as "A" + 3/8 in. with the same tolerances as at "A". "B" may also be given a maximum dimension if desired, since the minimum dimension will be controlled by "E". This will provide a somewhat wider range of dimensions available for various reflector designs. "E" should be specified as 1/8 in. minimum to avoid any tendency for the glass to chip or shatter under the vibration incident to operating conditions.

"D", the overall depth of the reflector, may be specified as a suitable average dimension, which with limits of $\pm$ 1/4 in. should be ample for the various designs of reflector conforming to dimensions "A," "B" and "C," and at the same time the distance between the reflector and a properly designed shield will in every case be ample to provide suitable clearance for mounting. An average

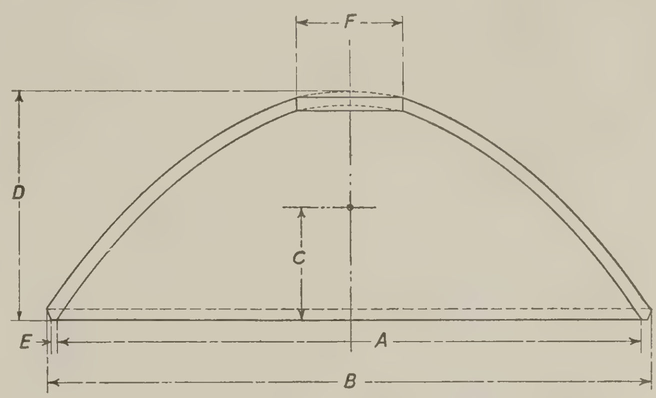


Fig. 2. Cross Section of a Locomotive Headlight Reflector

dimension for "D" will probably be found to be in the neighborhood of 6¼ in.

The remaining dimension "F" provides a hole at the apex of the reflector of suitable size to enable proper focusing of the headlight lamp and provide clearance for such parts of the focusing device as may project through the reflector. An average dimension will probably be found in the neighborhood of 2¾ in.

The line from points "E" is the basis for the design of a glass reflector, and it is felt should properly be the basis for all dimensions. If this is done, the dimensions will be taken from the same points of origin as for a metal reflector, and on this basis the diameter of the reflector would be the outside diameter at the mouth of the reflector, and the focal center would be measured from the outside, or back surface, instead of from the inside, or front surface, of the reflector.

Locomotive Headlight and Cab Lamps

The development of the 250 watt headlight lamp in the G-25 bulb has several advantages in addition to the advantages from a manufacturing standpoint that are worthy of careful consideration, chief of which, perhaps, is its superior mechanical strength as compared to the G-30 bulb. With the reduction in the size of the lamp the difficulty of focusing, where use of the G-30 bulb in combination with certain glass reflectors, has been experienced due to the larger bulb not permitting proper adjustment, should be overcome. Another advantage of the reduced size will be afforded by the smaller space required for storage in the storehouses as the smaller lamp with present packing practice will occupy less than one-half the space.

The similarity of bulb of the 250 watt and 100 watt lamps, however, is a serious objection because of the liability of mixing the road locomotive and yard locomotive lamps, which is certain to occur to a greater or less extent unless some very distinctive characteristic can be provided between the two types of lamps. This, your Committee feels, can best be done by the Lamp Companies working out the 100 watt yard locomotive lamp in some other than the G-25 type of bulb. In the meantime it would seem advisable for the railroads to consider the

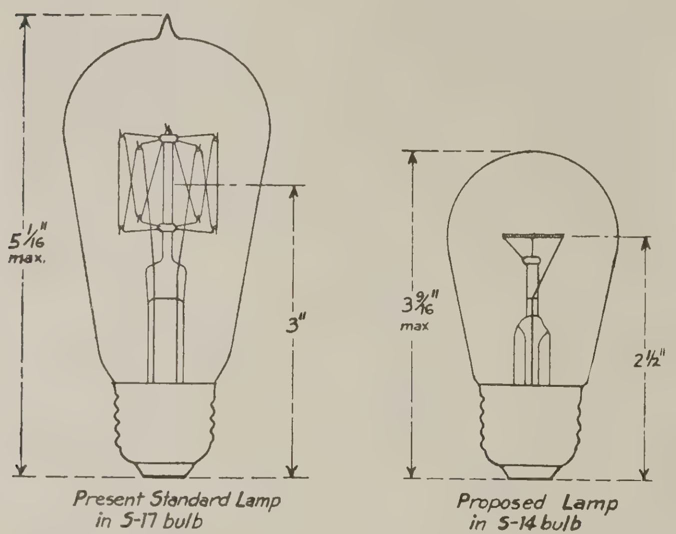


Fig. 3. Present Standard and Proposed Lamp for Classification Lamps

250 watt, G-25 bulb, and express opinions by the time of the next convention as to whether or not it should be generally adopted.

The 15 watt, S-14 bulb cab lamp appears to have been quite satisfactorily developed, and, while information is not available as to its service on any appreciable scale, the indications are that the new cab lamp is an improvement that should be generally acceptable. The change from the S-17 to S-14 bulb permits of smaller cab and gage lighting fixtures, which is very desirable; laboratory tests indicate that it is stronger mechanically than the present S-17 lamp; the light center length, while 1/2 in. shorter, and the changed filament construction will permit of its use satisfactorily in the present type of classification lamp fixtures without any change in socket position; and storage space advantages, although not so great as those in the case of the 250 watt, G-25 bulb lamp will be afforded.

In view of the question brought up by some of the railroads as to whether or not a change of socket position would be necessary in the present classification lamps to accommodate the new S-14 bulb cab lamp, a series of tests were made at the Nela Park laboratories of the National Lamp Works to determine the matter. A report from the General Sales Department at Nela Park covering results of these tests is appended to the present report of your Committee, from which it is concluded that as the distribution of light from the present standard classification lamps is assumed to be satisfactory there would be no change necessary to utilize the proposed new S-14 bulb lamp.

This lamp is now commercially available and in view of its apparent decided advantages your Committee recommends that the railroads try it out on a large enough scale under regular operating conditions to secure information as to its merits as compared to the present S-17 bulb lamp to determine whether or not it should be adopted as standard for cab lighting service.

Alternating Current Headlight Generators

The state of development of the a.c. type of headlight generator is not greatly different from that of last year. No new makes have been introduced, apparently because of no urgent demand for this type, and the fact that so far certain of the manufacturers do not approve the use of permanent magnets which this type of generator for locomotive headlight service necessarily involves.

Only two companies at this time are offering the a.c. generator, a few units of each make being used largely in test service. A few of the railroads have recently made installations for comparative test purposes and while satisfactory service on the whole is being secured from those now operating, more complete information as to the desirability of this type is hoped for after the present testing period has more fully developed the characteristics of this type of unit.

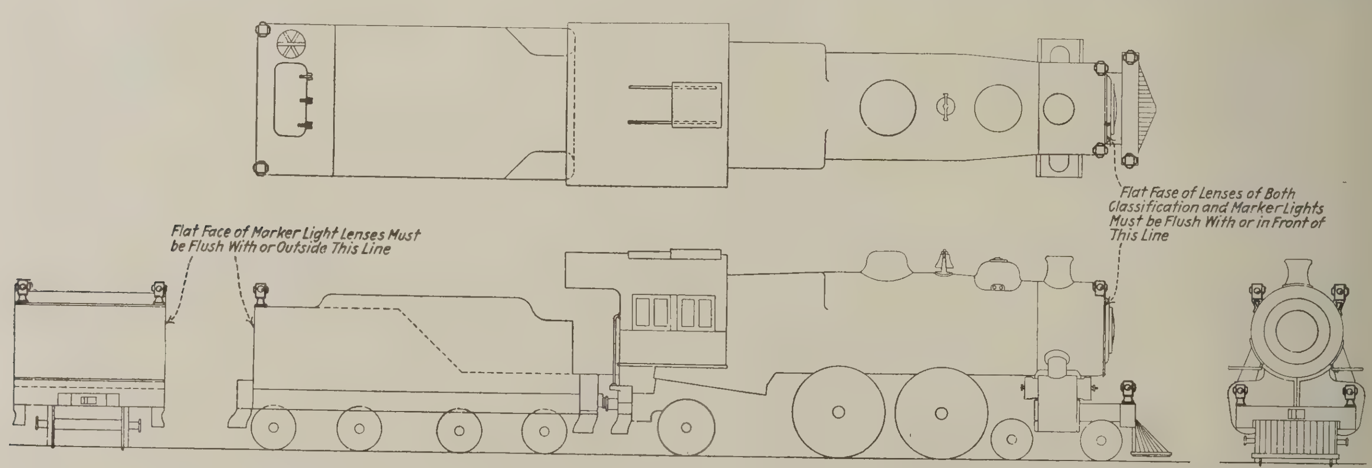


Fig. 4. Side Elevation of Locomotive Showing Proposed Positions for Classification and Marker Lamps

Headlight Generator Bearings

While the ball bearing is the present standard type for headlight generators some experimental applications of the roller type of bearing have recently been made and certain instances of which your Committee has been in-

formed have shown that the roller bearings after a period of nine months' continuous service there still in apparently perfect condition. Further experiments of this nature will be followed with interest as it may be found that certain advantages may be secured from this type of bearing that may not now be the case with the present ball bearings.

Considerable ball bearing trouble has always been experienced with the headlight generators and while a portion of this trouble may have been due to selection of improper bearings for the particular service, or from improper mounting practice it is well known that a considerable portion of the trouble has resulted from improper maintenance practice. With a view to determining the causes of ball bearing trouble one of the large ball bearing companies had their engineers make a systematic investigation of the general condition as well as conducting some experiments. As a result of their investigation and experiments some very interesting conditions were developed from which suggestions have been offered by the manufacturers to assist in remedying the difficulties experienced.

It was found that many of the turbo-generator shafts were badly sprung, presumably caused by careless workmanship in disassembling the unit at the time of making repairs. These shafts were scrapped. In the meantime it was necessary to rebore and bush the bearing housings and enclosures which were badly worn. This condition of bent shafts and worn housings was soon traced to causes which apparently no one suspected of giving trouble. This point was the springing of the shaft due to the drawing up or locking on of the turbine wheel and rotor. New shafts were set and an indicator run across them showing them to check accurately, but when drawing up the clamping nuts on the various parts the shaft would spring or bow, so much so that the indicator read, in some instances many thousandths of an inch out. This naturally would cause serious trouble when operating at the high speeds at which the turbo-generators run.

Some of the suggestions offered to remedy the bearing troubles follow:

1. Carefully check all shafts for concentricity and straightness.

2. Carefully check all clamping nuts and washers, making sure the face which clamps against a hub or other parts sets at absolutely right angles to the shaft axis.

3. Carefully check the hub of each part mounted on the shaft to make sure that it is faced absolutely at right angles to the shaft axis or bore of the hub.

4. Assemble all parts, including bearings, tighten up all nuts on the parts and check assembled shaft and parts carefully with an indicator.

5. It is then necessary to disassemble the shaft and parts for reassembling in the machine, and all parts should be used on the shaft with which they have been checked.

6. Free running ball bearings should be used to prevent binding at the temperature produced in these machines.

7. Prevent all water entering the bearing housing or enclosure. This can be done by using revolving fingers outside the housing.

8. It is desirable to make a fine wire gauze strainer and insert in the lubrication hole to prevent intrusion of dirt when applying lubrication.

9. See that the bearing enclosures will allow the lubricant to circulate freely around the bearing. Attention is called to this point as it is believed there are some designs where the bearing is shrouded with washers and other parts so that it is practically impossible for the lubricant to circulate freely.

Respectfully submitted,
COMMITTEE ON LOCOMOTIVE HEADLIGHTS AND CLASSIFICATION LAMPS.

Locomotive Classification Lamp Tests

Result of Tests Conducted by National Lamp Works of General Electric Company for American Railway Association

GENTLEMEN:

The following is a brief report of tests conducted by our engineering department on typical locomotive classification lamps equipped with the standard and proposed new standard locomotive cab lamp.

Purpose of Test

These tests were made to determine the alteration in the distribution of light from a typical locomotive classification lamp when the proposed new locomotive cab lamp was used instead of the present standard lamp.

In addition information was derived on the change in light distribution effected by using the present standard lamp in a classification lamp where the socket position had been changed to bring the light source of the proposed new standard into the focus of the lens system.

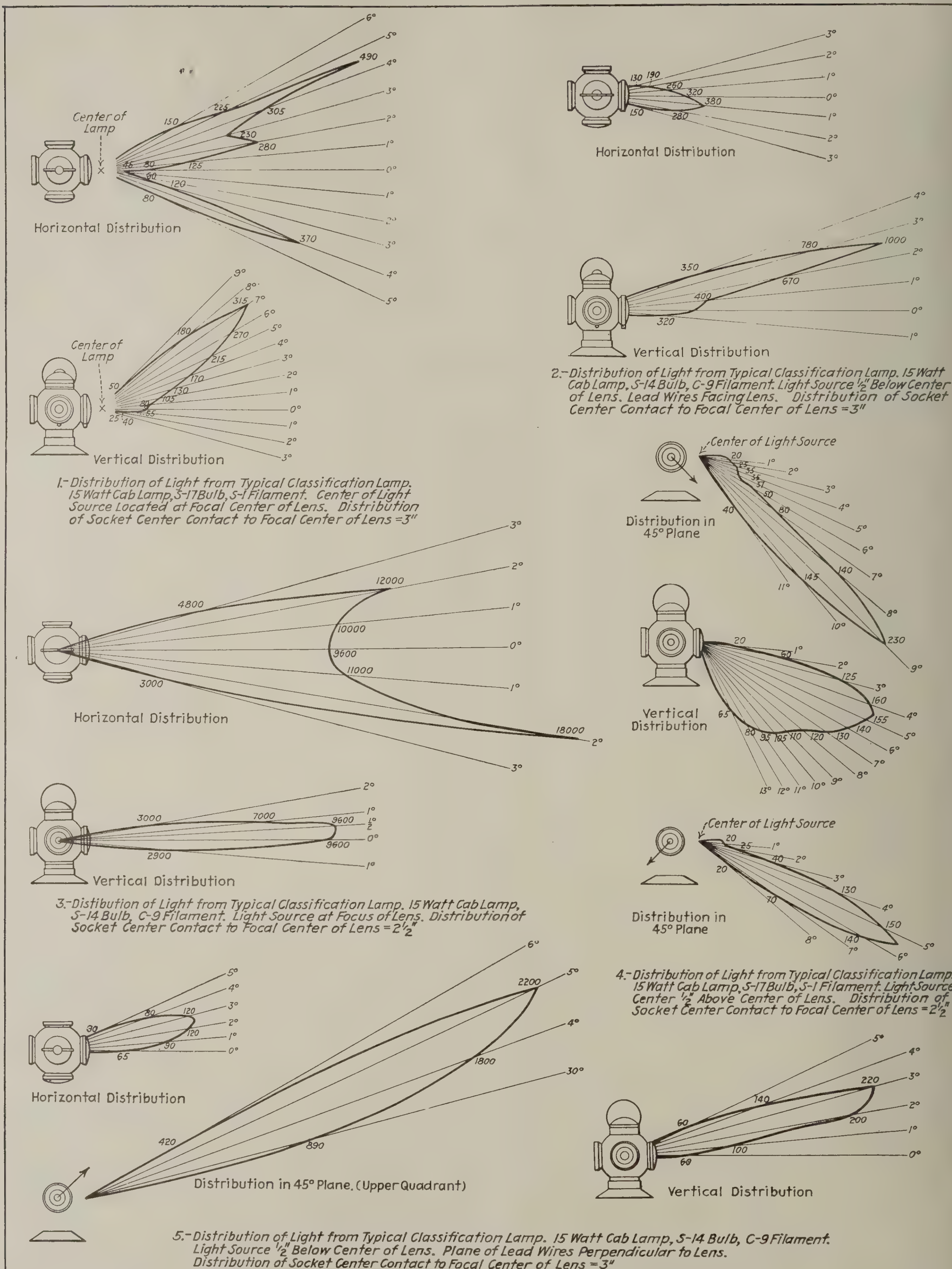
Scope of Tests

Curves of the light distribution of the Armspear Company and Adams & Westlake Company standard classification lamps were made with a standard 15 watt, 33 volt, S-17 bulb, 3 in. light center length, S-1 filament construction, 5-1/16 in. maximum overall length, mazda B cab lighting lamp, and the proposed new standard lamp of the following specifications: 15 watt, 33 volt, S-14 bulb, 2½ in. light center length, C-9 filament construction, 3-9/16 in. maximum overall length. The following tests were made:

1. Distribution of light in horizontal and vertical planes through respective axes of the lantern when the present standard lamp was placed in the lantern with the center contact of the base 3 in. below the focus of the lens system.

2. Distribution of light in horizontal and vertical planes through the respective axes of the lantern when the proposed new lamp was placed in the lantern with the center contact of the base 3 in. below the focus of the lens system and the light source was ½ in. below the focus.

3. Distribution of light in horizontal and vertical planes through the respective axes of the lantern when the proposed new lamp was placed in the lantern with



Curves Showing Light Distribution from Standard Classification Lamps Fitted With Present Standard and Proposed Standard Bulb With Socket in Two Positions

the light source in the focus of the lens system, the base contact being 2½ in. below the focus.

4. Distribution of light in horizontal, vertical, and 45 deg. planes through the respective axes of the lantern when the present standard lamp was placed in the lantern with the center contact of base 2½ in. below the focus of the lens system. This condition would prevail in lanterns in which the socket position was changed to place the light source of the proposed new lamp at the focus.

5. Distribution of light in the horizontal, vertical, and 45 deg. planes through the respective axes of the lantern when the filament of the proposed new lamp was placed ½ in. below the focus of the lens system, the center contact of the base being 3 in. below the focus. The plane of the lead-in wires of the lamp was placed at right angles to the plane of the lens.

6. The light output of the test lamps was held constant at 138 lumens. The test lamps had been carefully aged and rated.

7. The distribution curves were run on a horizontal rotator, the test plane being located at 35 feet from light source.

Results of Tests

Reference will be made to five drawings numbered 1 to 5 on which the distribution curves are plotted. It should be noted that the angle scale has been distorted to enable the curves to be adequately shown with candlepower readings at the test points.

As the distribution curves of the two makes of classification lamps are identical, the curves shown as part of this report represent both makes.

Curve No. 1. The horizontal distribution curve of No 1 clearly shows the variation in distribution caused by the non-uniformity of the light source in the form of bright filaments. At long distances the lens appears to be full of light. The total spread of light is approximately 13 deg. The distribution in the vertical plane about equals that in the horizontal with a maximum 7 deg. above the horizontal.

Curve No. 2. If the proposed new lamp is used, in the present installed lanterns the horizontal distribution will be narrowed to approximately 8 deg. while the vertical distribution is narrowed to 7 deg. with the maximum at 2½ deg. above the horizontal. The shift of the maximum of the horizontal curve is due to the fact that the filament was not placed exactly symmetrical with respect to the optical axis of the lens system.

Curve No. 3. When the light source of the proposed new lamp is located at the focus of the lens system, the light is directed in a narrow beam of high candlepower. The horizontal distribution is approximately 9 deg. and the vertical distribution 7 deg. The concentration of the light source gives a very high intensity compared to the present standard.

Curve No. 4. If the socket in the classification lamp were changed to place the light source of the proposed new lamp at the focus of the lens system, then the present lamp would give a distribution as shown on No. 4. There is practically no light above the horizontal. In one 45 deg. plane the maximum is 9 deg. below the horizontal, in the vertical plane the maximum is 4½ deg. below the horizontal, while in the other 45 deg. plane the maximum is 5½ deg. below the horizontal.

The test would indicate that the lens of the lantern would be dark to the tower man under the conditions of test.

Curve No. 5. In order to compare the distribution of the light from the lantern with the filament of the proposed new lamps in different positions, curve No. 2 was made with the lead-in wires facing the lens while curve No. 5 was made with the lead-in wires at right angles to the plane of the lens.

The horizontal distribution is about the same, assuming that the filament was symmetrical with the axis of the system. In the actual lamp this cannot be because there is no filament between the lead-in wires on one side. It should be noted that the candlepower is decreased about 70 per cent.

The vertical distribution is about the same in spread but the intensity is reduced about 78 per cent at the maximum 3 deg. above the horizontal.

The turning of the filament seemed to have made a high intensity beam in the upper half at an angle of 45 deg. to the vertical. This beam is approximately ten times the brightness of the beam in the vertical plane.

Conclusions

As the writer is not familiar with the criteria by which the performance of a classification lamp is judged, no statement of the effect which would be secured by a change in lamp and socket can be made.

If the distribution from the present standard lamp is satisfactory, it is the writer's opinion that no change of socket position would be necessary to utilize the proposed new lamp, assuming that the lowering of the beam 4½ deg. would not cause any harm.

Respectfully submitted,

C. R. Stover,
General Sales Department,
National Lamp Works of the
General Electric Company.

Report of Committee on Illumination

Changes in the Industrial Lighting Codes. Diversity of Opinion as to How Flood Lighting Should Be Applied

Committee:—

L. S. Billau, chairman, assistant electrical engineer, Baltimore & Ohio R. R.; J. L. Minick, assistant engineer, Pennsylvania System. A. H. Gerald, assistant electrical engineer, Pullman Company.

To the Members:

Conditions during the past year rendered it impossible for your Committee to hold any meetings or take up new work of any magnitude. The report, therefore, is confined practically to a review of development in the in-

candescent lamp and illumination fields that are of interest to railway electrical engineers.

Incandescent Lamps for Train Lighting Service

About the only changes that have taken place in train lighting lamps during the past year are some slight changes in the lumen rating of certain sizes and an increasing demand for the gas filled or type C lamps and corresponding decrease for the type B or vacuum lamps. In tables 1 and 2 are listed train lighting lamps now commercially available, these being segregated more or less arbitrarily into a group comprising those lamps for which there is a large or increasing demand and those for which there is a limited or decreasing demand. A comparison with the corresponding tables published in the report of the Committee last year will show in detail the changes that have taken place.

TABLE 1

Size in Watts	Type and Size of Bulb	Vacuum (B) or Gas Filled (C)	Lumens Rated Initial	Lumens Approx. Mean Through-out Life
	Lamps for Which There Is a Large or Increasing Demand			
	30-34 Volt Range			
15	S-17	B	155	135
15	G-18½	B	144	125
15	PS-16	C	151	142
25	S-17	B	268	214
25	G-18½	B	240	204
25	PS-16	C	310	285
50	PS-20	C	705	670
75	PS-22	C	1178	1120
100	PS-25	C	1630	1550

TABLE 2

Size in Watts	Type and Size of Bulb	Vacuum (B) or Gas Filled (C)	Lumens Rated Initial	Lumens Approx. Mean Through-out Life
	Lamps for Which There Is a Limited or Decreasing Demand			
	30-34 Volt Range			
15	PS-16 Frosted	C	144	122
25	PS-16 Frosted	C	288	258
20	S-17	B	208	175
50	S-19	B	560	392
50	G-30	B	560	437
50	PS-20 Bowl Frosted	C	670	630
	60-65 Volt Range			
15	S-17	B	144	125
15	G-18½	B	133	116
25	S-17	B	253	202
25	G-18½	B	235	200
50	S-19	B	515	360
50	PS-20	C	600	546
75	PS-22	C	1005	905
100	PS-25	C	1430	1260

The 50 watt gas filled lamp has largely superseded the vacuum types of the same size and it would appear that the 25 watt type C lamp will also rapidly take the place of the older types. While there is a gradual increase in the use of the 15 watt type C lamp it is questionable that it will supplant the vacuum type for general train lighting service as long as it furnishes but slightly more illumination yet costs considerably more. The principal field today for the 15 watt type C lamp is where this lamp is used in the same compartment of a car with type C lamps of larger sizes as part of the main lighting system. On account of the difference in the color of the gas filled and vacuum lamps a much more pleasing effect is secured by using the gas filled lamps throughout.

On account of the very objectionable glare from clear gas filled lamps they should always be used with suitable enclosing glassware, or reflectors for the medium and smaller sizes. However, as the 15 and 25 watt lamps will be used to a great extent in existing fixtures where a large proportion of the bulb is exposed to direct vision the full frosted bulb should be used. These two sizes of type C lamps are regularly furnished in the frosted bulb but are available in the clear bulb as a special lamp at the same price.

Incandescent Lamps for Locomotive Service

The lamp manufacturers have now developed the new cab lamp in the smaller size bulb to the point where they are in position to manufacture them on a commercial basis. Table 3 shows the essential differences between the present standard 15 watt 33 volt locomotive cab lamp and the proposed lamp.

TABLE 3

	Present	Proposed
Size-Watts	15	15
Rated Initial Lumens	104	138
Type of bulb	S-17 tipped*	S-14 tipless
Maximum overall length	5 1/16"	3 9/16"
Maximum diameter	2⅛"	1⅞"
Light center length	3"	2½"
Filament mounting	S-1	C-9 (Coiled Ring)
Standard package quantity	120	200

* In line with general change from tipped to tipless bulbs the present cab lamp will be furnished in future in tipless bulbs.

The principal advantages of the proposed new cab lamp are:

1. Its much smaller size physically will permit considerable reduction in the size of cab light fixtures, a change which will be very desirable.

2. Due to its smaller size there should be some reduction in mechanical breakage of those lamps in the cab that do not have a protecting mounting.

3. For use in classification lamps it will furnish higher intensity of illumination than the present S-17 bulb lamp, although with the present standard socket mounting the center of the light source is ½ in. below the center of the lens. The Report of the Committee on Locomotive Headlights includes the results of an extensive series of tests made to determine the effect of this change in cab lamp construction on the illumination produced in classification light use.

4. Laboratory tests indicate that the proposed new lamp should be stronger mechanically, but until this can be verified from the results obtained from the use of the new lamp in service conditions on a large scale no prediction can be safely made as to its probable life performance.

Some railroads are already trying out this lamp on a large scale. Your Committee strongly urges that a large number of the railroads arrange to try out this lamp as quickly as possible so that a definite decision can be reached during the coming year as to the advisability of adopting this lamp as standard for locomotive cab light service.

During the past two years the manufacturers have been making some 250 watt 32 volt headlight lamps in the G-25 bulb and results from service indicate that this lamp is superior to the G-30 bulb due to greater basing strength obtained by the use of the long shell base. In addition, troubles that were experienced with some of the earlier glass reflectors due to insufficient clearance between the bulb and reflector, preventing proper focusing, will be overcome with the smaller bulb. This smaller size bulb will also result in over a 50 percent reduction in storehouse space as required for the present G-30 bulb lamps, based upon dimensions of cartons in which these two sizes of bulbs are now packed. Your Committee feels, however, that before it can recommend any widespread use of the 250 watt headlight lamp in the G-25 bulb that it will be necessary for the lamp manufacturers to make some change in the bulb for the 100 watt headlight lamp so that the two sizes can be readily distinguishable from their physical dimensions. In the meantime it is recom-

mended that the railroads try out this lamp on a small scale with a view to collecting reliable data of its performance under service conditions as compared with the present headlight lamp.

While it is fully appreciated that any change in the design or construction of a manufactured article that is used as widely or on as large a scale as incandescent lamps in steam locomotive service must be made cautiously and slowly, it must be realized that the use of the incandescent lamp in this field is still comparatively new and that improvements are to be expected from time to time. Considering how large an item of the total cost of operation and maintenance of electric headlights on steam locomotives are the lamps themselves as well as the seriousness of lamp burnouts on the road, your Committee feels that the lamp manufacturers should be encouraged, in whatever ways are practicable, to work constantly on developments in locomotive headlight and cab lamps that will not only improve their quality but insure greater reliability of performance.

Developments in the Incandescent Lamp Field of Interest to Steam Railroads

Among the developments in the incandescent lamp field that have taken place during the past year your Committee would call attention to the following as more or less of general interest to railroad electrical engineers.

Tipless Bulbs. During the past year manufacturers have made considerable progress in changing over their production in various sizes of lamps to the tipless construction and comparatively few lamps are now being made tipped. It is probable that the coming year will see the entire elimination of the tipped lamps.

Mill Type Lamps. The use of the mill type lamps for service where lamps are subjected to severe usage mechanically, or vibration and shock, is constantly increasing. It would appear, however, that this type of lamp is making a better showing in portable light extension cord service than in service where subjected to vibration. Your Committee, however, has been unable to secure any data showing the actual relative performance of this type of lamp as compared to carbon or other types of tungsten lamps in service for which the mill type has been primarily developed. It is felt that to considerable extent local conditions such as extent of mechanical breakage, thefts, etc., will affect the economy of using the mill type tungsten lamp in extension cord service as compared to carbon lamps, with the consequence that the railroads will have to determine largely for themselves the desirability of using this type of lamp.

Digest of Industrial Lighting Codes that Have Been Issued by Various States

Last year the Report of the Committee on Illumination included a digest of lighting codes, laws or other regulations pertaining to industrial lighting that had been put into effect by the various states. With a view to keeping this information up to date this committee will include in its annual report revisions and additions to these codes that have been put into effect during the year. The following changes and additions to the digest of the codes as published in Volume 13 of the Proceedings of the Association of Railway Electrical Engineers for 1922 are required to bring them up to date:

Fig. 1. Night View in Classification Yard Illuminated With Centralized Flood Lighting System

Page 109—Under the heading RULES AND ORDERS OF THE VARIOUS CODES, after the word "Wisconsin" add "Massachusetts."

Page 110—In the paragraph headed GENERAL REQUIREMENTS: OHIO, WISCONSIN, etc., add "Massachusetts."

Page 110—In the paragraph headed NATURAL LIGHT: WISCONSIN, OREGON, CALIFORNIA, add "Pennsylvania."

Page 111—Under column headed PENNSYLVANIA, make the following changes and additions:

On line 3 change Sec. 1 to Rule 376.
On line 4 insert Rule 377.
On line 5 change Sec. 2 to Rule 380.
On line 6 change Sec. 3 to Rule 377.
On line 8 change Sec. 4 to Rule 378.
On line 9 change Sec. 5 to Rule 370.
On line 10 omit Sec. 6.
On line 11 insert Rule 376.
On line 13 insert Rule 376.

Add a new column headed "Massachusetts" with the following items:

Line 3 Rule 1
Line 5 Rule 2
Line 6 Rule 3
Line 8 Rule 4
Line 9 Rule 5

Add a new line entitled "Classification" with the notation Rule 6 under the column headed "Massachusetts."

Fig. 2. Night View in Yard Showing Effect of Background Illumination

Page 112—In the paragraph headed SHADING OF LAMPS FOR OVERHEAD LIGHTING: WISCONSIN, OREGON, CALIFORNIA, add "Pennsylvania."

Page 114—The following changes should be made in the values given for Pennsylvania.

	Minimum	*Recommended*
Roads & Yards	.10	.25— 2.00
Storage	.25	2.00— 5.00
Stairways & Aisles	1.0	2.00— 5.00
Rough (1) Mfg.	.5	2.00— 5.00
Rough (2) Mfg.	1.0	2.00— 5.00
Medium (3) Mfg.	2.0	5.00—10.00
Fine (4) Mfg.	3.0	5.00—10.00
Very Fine (5) Mfg.	5.0	10.00—20.00
Office Work	3.0	5.00—10.00
Toilets & Washrooms	1.0	2.00— 5.00

To this table add a line for Massachusetts with the following values:

	Minimum	*Recommended*
Roads & Yards	.02	.05— .25
Storage	.25	.50— 1.00
Stairways & Aisles	.50	1.00— 2.00
Rough (1) Mfg.	.50	1.00— 2.00
Rough (2) Mfg.	1.0	2.00— 4.00
Medium (3) Mfg.	2.0	4.00— 6.00
Fine (4) Mfg.	3.0	6.00— 8.00
Very fine (5) Mfg.	5.0	8.00—15.00
Office Work	...	...—....
Toilets & Washrooms	.50	1.00— 2.00

Developments in Passenger Car Illumination Practice

In line with the development of artificial illumination practice in general during recent years there is now a decided trend towards higher intensities of illumination in passenger cars. This has been made possible largely through the development of the larger sizes of gas filled tungsten lamps for car lighting service while the impracticability of using these lamps, unless properly shaded, has brought about a much wider use of lighting units with partially or totally enclosing glassware. As a ceiling type of lighting unit with enclosing opal bowl of the same design as the present Pullman standard lighting unit, or similar to it, is becoming to be widely used in coach lighting service your Committee felt that data on the illumination results produced would be of interest. Illumination tests were therefore conducted on a new coach equipped with this type of unit, the test procedure being the same as that followed in the day coach lighting tests made in Cleveland in 1913, in order that the results would be on a comparable basis. For ready comparison there is given in Table 4 the results of the Cleveland test on the Holophane velvet finish prismatic glass reflector with 50 watt type B lamp, which type of lighting unit was and is still widely used for coach lighting, and the Pullman type of unit with Berylite opal bowl and 100 watt type C lamp.

TABLE 4

Kind of Lighting Unit	Velvet finish prismatic glass reflector		Light density enclosing opal bowl	
Type	Holophane No. 18226VF		Berylite No. 206	
Size and type of lamp	50 watt G-30 tungs. B		100 watt PS-25 tungs. C	
No. units per car	10		10	
Spacing	2-seat		2-seat	
Total watts	500		1000	
Lumens per lamp (Corrected values)	400		1600	
Lumens per complete lighting unit	344.5		1178	
	Illumination in foot candles			
Illumination plane	45 deg.	Hor.	45 deg.	Hor.
Window seats	1.50		2.48	
Aisle seats	1.94		3.07	
Average seats	1.72	2.30	2.77	4.38
Aisle only		3.29		5.76
Average car		2.49		4.65

For baggage car illumination the standard RLM type of porcelain enameled steel reflector with a 50 watt type C lamp mounted close to the ceiling will be found a most satisfactory lighting unit and is beginning to be used in this service. Results of illumination tests with this type of unit are given in the 1920 Report of the Committee on Illumination.

Flood Lighting Methods of Illumination of Railroad Yards

Partially as a result of the impetus received during the War there is a constantly increasing use of flood

Fig. 3. Typical Wood Pole Structure for Supporting Battery of Lighting Units

lighting projectors by the railroads primarily for outdoor illumination and to a limited extent for indoor illumination such as roundhouses where special low-powered projectors have been employed. While it is probable there have been many cases where this type of lighting has not been correctly applied or where other types of lighting units would have been better adapted, with consequent unsatisfactory results, there is no doubt but that the use of this form of lighting is being rapidly extended for the illumination of large outdoor areas such as railroad yards and engine terminals. In view of the general interest in the subject of better illumination of railroad transportation yards your Committee has begun a study of this subject with particular reference to the use of the flood lighting system of illumination. It has been impossible this year to go into the matter sufficiently in detail to permit presenting more than a few general comments on various features of the subject without drawing any definite conclusions. This part of the report is therefore in the nature of a progress report only.

A questionnaire was sent out by the Association to a number of the representative railroads to ascertain their present practice. The data secured was necessarily incomplete but indicates the present trend, the results of which are summarized in Table 5.

TABLE 5

Number of railroads replying to questionnaire	23
Number using flood lighting in yards or considering installations in immediate future	15
Number of installations in which units are concentrated in batteries at relatively few points as compared to distributed arrangement through yard	12
Number using wood pole structures as compared to steel poles or towers	12
Range of mounting heights for units mounted in batteries	60 to 85 feet
Range of mounting for distributed mounting	35 to 65 feet

All of the railroads that submitted any remarks on the subject commented favorably on this system for yard lighting as compared to other systems using distributed pendant lighting units. Your Committee, in discussing the subject with different railway electrical engineers and other illuminating engineers who have given it some study, find there is a difference of opinion as to the merits of the flood lighting system as compared to the other systems of yard lighting as well as a diversity of views among the engineers favoring the flood lighting as to how it should be applied, this latter being apparently largely due to misconception of the details of the problem involved. The following covers briefly some of the phases

Fig. 4. Typical Steel Tower for Supporting Lighting Units

of the subject of flood lighting illumination for railway classification yards:

1. *Benefits Derived from Improved Illumination of Classification Yards.* Efforts made to secure data showing specifically what benefits have accrued in the operation of yards where modern flood lighting systems have been installed have thus far been unsuccessful. Local conditions influence the situation appreciably, which makes it difficult to draw general conclusions as to the extent or amount of the benefits that have resulted. Information obtained indicates that improvements to a

greater or lesser extent have been secured with respect to the following:

(a) Speeding up of cars handled in the yard at night time.

(b) Reduction in cars damaged by rough handling and collision in the classification yard with consequent reduction in claims, delays in delivery of goods, loss of service of the damaged cars, etc.

(c) Reduction in losses due to pilfering on account of more effective policing possible with a well illuminated yard.

(d) Improved working conditions and increased safety for employees working in the yard.

That these benefits are appreciable is evidenced by the fact that certain railroads have during the past year authorized relatively large expenditures for improved yard illumination.

2. *Illuminating Problems Involved.* Some of the illuminating engineers who have had occasion to make studies of yard lighting have not had opportunity to become fully acquainted with the working conditions and methods of operation involved with the consequence that some of the lighting systems installed have not always given the illumination results desired. For the classification yards particularly of the gravity type the essential feature is the providing of illumination of character and distribution that will enable the car riders to distinguish at relatively long distances at any point in the yard the cars in the yard ahead of them and thus be able to control the speed of the cars on which they are riding so as to prevent damage due to collision on the one hand, or stopping short and thus failing to couple on the other. It is also desirable to have the throat of the yard and ladder tracks visible from the hump so as to observe when cars have cleared the fouling points at switches, etc., particularly in yards not equipped with a modern interlocking plant for operating switches from a centralized point. A system of lighting that will provide proper illumination for these purposes will also be sufficient to disclose the irregularities of surface in the spaces between the tracks through the yard and other obstructions, which will be adequate for the safety and convenience of the car riders and other yard forces.

Lighting systems have been laid out largely from the point of view of providing sufficient average intensity of illumination upon the working plane throughout the yard for the purposes required, at the same time striving to secure a certain amount of uniformity of illumination and elimination of objectionable glare. In some recent studies made the problem has been considered from the point of view of designing a system of lighting that will provide by contrast, background illumination, silhouetting and sharp shadows uniform in direction that will give the desired visibility of the cars at long distances, etc., at very much lower average illumination intensities and consequently less energy consumption. There is undoubtedly opportunity for considerable study and experimental work along these lines to develop a system of yard lighting that will give the most effective results with minimum investment and operating costs and at the same time be free from objectionable glare effects and other defects that exist in some of the present installations.

3. *Systems of Lighting in Use.* There is a wide diversity of practice in yard lighting both with the systems using pendant type of lighting units and with that employing flood lighting projectors. With the flood lighting system the two extremes are represented, on the one side by large batteries of projectors mounted on as small a number of structures as conditions will permit, and on the other by units mounted individually on poles through the yard. In the former from four to about sixteen units are mounted on a structure from 65 to 90 feet in height located at the hump, either alone or with others spaced at 2000 feet to 3000 feet distant in the yard with the lighting units directed towards each other. In the other single units are mounted on poles from 45 to 65 feet in height spaced about 500 feet through the yard or along sides with lighting units facing along the direction of traffic. Some of the most recent installations made fall between these two extremes. Two to six units are mounted on a tower and from two to three times as many towers are provided as with the highly centralized system. In view of conflicting claims for the various systems and lack of reliable comparative data as to their relative merits your Committee has deemed it inadvisable to present at this time definite views on the advantages and disadvantages of these various systems of yard lighting. However based on observations it would appear that the distributed system of flood lighting projectors in which they face along the direction of traffic does not give as desirable results as the system laid out to give background illumination with silhouetting effects and reasonably sharp shadows.

Fig. 5. Typical Steel Pole Structure for Supporting Single Lighting Unit

4. *Lighting Equipments and Types of Supporting Structures.* For practically all of the installations of railway yard flood lighting the standard commercial types of flood lighting projectors have been used of 1000 watt size. The mirrored glass reflector is most widely used while the cast iron type of housing appears to be the most popular although favorable reports have been re-

ceived of units of composite construction of sheet metal and cast iron fittings the metal being lead-ized or otherwise treated to resist corrosion. The multiple system of lighting is employed in all of the installations that have been reported to the Committee current being distributed generally at 2300 volts and stepped down at each tower to the nominal 115 volt lighting circuit. For supporting structures wood construction consists generally of two guyed poles 70 to 90 feet in height spaced ten or twelve feet apart with a suitable platform at the top on which the projectors are mounted while steel structures consist of single poles or towers of self-supporting design with suitable platform for mounting the projectors. As indicated in Table 5 the wood pole structure is more widely used than steel towers which is possibly due to the fact that on account of the lack of any developed or standardized design of steel tower with its platform for this purpose it is more difficult and expensive to secure them than the wood structures where a small installation is being made consisting of probably only two or three towers. Some railway engineers favor the wood pole construction from a maintenance point of view on account of not requiring the periodical painting necessary with a steel structure. Comparative costs of the two types will vary appreciably with the number of towers involved and differences in details of design with the consequence that such cost figures as the Committee could present at this time would be of little general value. In designing structures for this purpose special consideration should be given to easy and safe access to the projectors which will be found to be of great assistance in keeping the lighting units properly maintained, cleaned and focused. Provision should be made for easy climbing of the structures as well as adequate working space and guard rail protection for the benefit of the maintenance force who have to renew and focus lamps under adverse weather conditions and who in general are not accustomed to working in high places.

In Figs. 1 and 2 are illustrated typical installations of flood lighting in railroad yards and in Figs. 3, 4 and 5 various designs of structures for supporting the lighting units.

Recommendations

Your Committee would recommend that the study of this subject be continued with a view to presenting in next year's report more complete data on existing modern yard lighting installations as well as present definite recommendations as to what constitutes the best practice as based on further experience and engineering studies of the problem.

Respectfully submitted,

Committee on Illumination.

Report of Committee on Electric Welding

A Comparison of the Costs of the Different Welding Processes as Applied to Railroad Shops

Committee:—

H. R. Pennington, chairman, supervisor of welding and electrical equipment, Chicago, Rock Island & Pacific Railroad; E. Hagensick, electrical engineer, Union Pacific Railroad; E. Lunn, electrical engineer, Pullman Company; E. S. M. Macnab, engineer of electric car lighting, Canadian Pacific Railway; G. T. Goddard, general electrical foreman, Illinois Central Railroad.

To the Members:

This report deals principally with the economic status of arc welding and is intended to assist members of this association in arriving at relative costs of electric arc welding and other processes, particularly that of oxy-acetylene.

Welding operations, regardless of the process used, are merely applications of heat in proper form to the metals to be welded. The economics of welding, therefore, is largely, if not entirely, a matter of the economics of heat production and utilization. In the long run, the cost at which heat may be produced, suitable for welding operations, determines the process which costs the least to use; and, as long as economic laws apply to railroad shops, the process which will supersede all others is the one which gets the desired results at the lowest cost of producing the heat.

The issue today is, principally, between the heat produced by the oxy-acetylene flame and the heat produced by the electric arc. The field of forge welding is such as to eliminate the process from competition with the other two. Except for very heavy parts, Thermit welding involves an expense for its application, as well as for heat production, which, relative to the gas and electric welding processes, is so high as to practically eliminate it from the field in railroad shops.

The cost of producing heat depends, therefore, to a considerable extent, upon how directly the heat is produced. Fig. 1 shows graphically the steps which are intermediate between the production and utilization of the heat in a railroad shop. It is to be observed that the source of heat, whether the electric arc process or the gas process is used, is electric power. In the manufacture of oxygen, whether it be by the air reduction process or by the electrolytic process, electric power is the energy used to make the oxygen. This oxygen must then be compressed in the tanks and the tanks transported to the store department. The store department delivers them to the manifold room, and the oxygen is delivered to the point at which it is used through a piping system. The manufacturer of the oxygen stands leakage up to the point at which the tanks are received by the store department. The leakage of the piping system, through which the oxygen is distributed to the points at which it is to be used, is paid by the railroad. Owing to the fact that oil cannot be used in the packing of the valves on the oxygen lines, the leakage of oxygen in the piping system amounts to a considerable figure.

The carbide, from which acetylene is made, is also a product of electric power. Carbide is made in an electric arc furnace. It must then be put in a metal container and transported to the user. It is then delivered to the acetylene generator room, where it is placed in the generator and combined with water to form acetylene gas. This gas is then delivered, through a piping system, to the point at which the heat is to be used.

The heat for electric arc welding is delivered direct from the power line to the arc welding machine, which merely converts the electrical energy into a form suitable for conversion by the electric arc into heat directly. It is obvious that the utilization of electric power for conversion directly into heat by the electric arc process involves a considerably less number of intermediate steps;

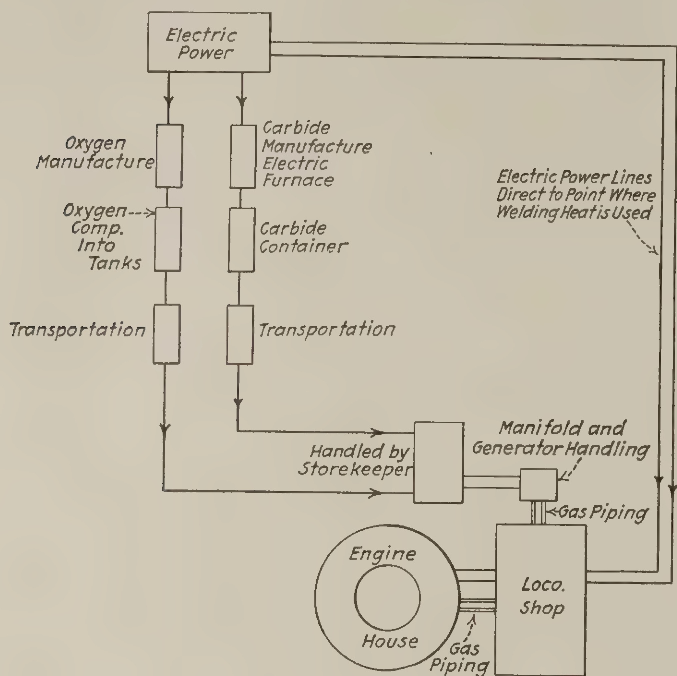


Fig. 1. Comparison of Methods of Producing Heat for Welding

and it could be assumed, without further investigation, that the cost of heat per B. T. U. is considerably less in the case of the electric arc process than the gas process.

Fig. 2 shows graphically the effectiveness with which

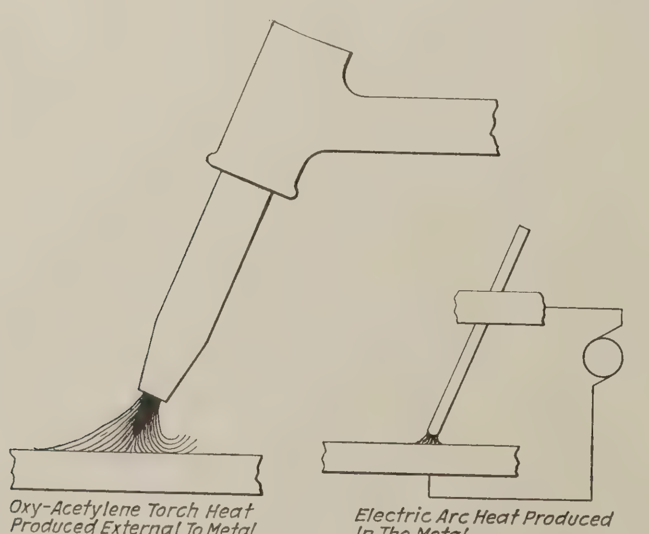


Fig. 2. Diagram Showing Effectiveness of Heat Produced by Gas Flame and Electric Arc

the heat produced by the gas process and the electric arc process is used. In the former process, heat is produced in a neutral flame external to the metal to be heated. Due to the kinetic energy of the gases and their high temperature, a very large portion of the heat is carried off in hot gases and does no useful work. In the latter process, on the other hand, practically all of the heat is produced internal to the metals to be welded. Under normal circumstances, the largest amount of heat is produced in the heavier piece, and the balance of it is produced in the arc flame itself and the metal electrode. It is estimated that about 90 per cent of the total amount of heat is produced either in the electrode or in the piece to be welded. There are no gases having kinetic energy —the heat losses are due to radiation and are relatively small.

Considering the cost of producing heat, without ref-

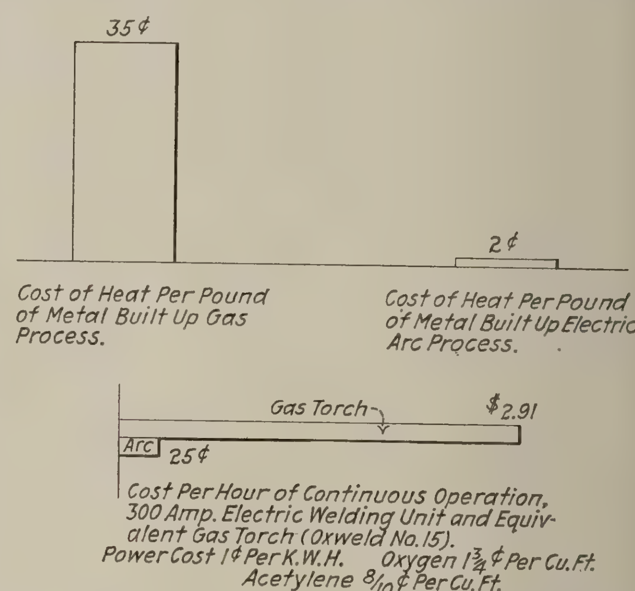


Fig. 3. Relative Thermal Economies of the Gas Torch and the Electric Arc

erence to the effectiveness of its use in the two processes, it is interesting to compare the cost of producing the amount of heat which is contained in the average pound of coal. Assuming that eleven thousand B.T.U. represents the average heat in a pound of coal, at $5.00 per

Size Rod Inches	Power K.W.H.	Arc Current Amp	Cost Per Hour	Cost Per Hour	Tip Size	Oxygen Cu. Ft.	Acetylene Cu. Ft.
1/8	4.5	120	$.045	$.53	6	19.2	23.7
5/32	6.3	140	.065	.80	7	32.0	30.5
3/16	6.7	165	.067	1.16	8	46.0	43.8
3/16	7.9	180	.079	1.51	10	60.0	57.2
1/4	9.6	200	.096	2.21	12	88.0	84.0
1/4	12.50	250	.125	2.91	15	116.0	110.0
1/2	30.0	400	.300				
Electric Power 1¢ Per K.W.H. Oxygen 1¾¢ Per Cu. Ft. Acetylene 8/10¢ Per Cu. Ft.							

Fig. 4. Comparison of the Cost of Gas Welding With Electric Welding

ton delivered to the railroad power plant; and figuring oxygen at 1¾ cents per cubic foot; generator acetylene at 8/10 of a cent per cubic foot; and electric power, which the railroad makes itself, at 1 cent per Kilowatt hour, with an overall efficiency of 50 per cent for the arc welding machine; the relative costs of the three sources of heat are as follows:

1 lb. coal	11,000 B. T. U. of Heat		¼ cent.
Oxy-acetylene	11,000	"	19.74 cents
Electric Arc	11,000	"	6.45 cents

Fig. 3 shows the thermal economy of the electric arc process and the gas process graphically. These figures show the relative cost to produce heat, as well as the effectiveness with which it is used. The data given on the cost per hour of operation of the two processes does not include any element of the relative amount of work possible to produce.

Fig. 4 shows, in parallel columns, at the center of the table, cost of production of the electric arc process and that of the equivalent size torch tips, which would be used in place of each size arc welding electrode. It is assumed that the gas process would use manifold oxygen, 50 lb. pressure, at the manifold and generator acetylene.

Exclusive of cutting, the welding operations done in railroad shops today, with either the gas or the electric processes, 85 per cent may be done as well, or better, with the electric arc than can be done with the gas process. The 15 per cent exception includes all brazing operations and a majority of the cast iron welding. On a number of large railway systems of the country, from 60 per cent to 80 per cent of the operations which may be performed by the electric arc process are being done in this way; and on many of the other large systems, the replacement of gas welding by electric welding has proceeded 25 per cent to 50 per cent of the possible replacement.

It appears that oxy-acetylene for welding will go the way of acetylene lighting for automobiles and acetylene lighting for houses and buildings. The present widespread use of the acetylene flame for welding is not due to any widespread preference for this process by those financially responsible for the operation of the railroads; but that the commercial use preceded that of arc welding is due rather, as in the case of automobile lighting, to the fact that these gases were already available, and that the initial development and installation cost necessary for its application was less than that of the electric arc. In view of the widespread movement to replace gas welding with electric welding, it is apparent that the time is rapidly approaching when the relatively small capital outlay will be made to eliminate the high operating expense of the gas welding process.

While it may be true that the actual application of welding does not generally come under the jurisdiction of the electrical men, they have, in the past, done much toward inciting interest, sufficient to result in at least initial purchases of arc welding equipment. As there is yet a great deal of work of this character to be done in the interest of arc welding, your Committee feels that the electrical men can do much towards the extension of arc welding by providing themselves with data on the economics of the process, proper equipment, and welding material necessary for the diversified applications of welding, and welding accessories.

In this connection, in order to eliminate any hazardous risk, incidental to arc welding, the use of the following safety precautions are recommended:

1. It is very desirable that for use with portable welding generating sets, a combination of a safety switch and receptacle be used. This equipment should be so interlocked that the plug may not be removed without first opening the switch, and may not be inserted unless the switch is open.

It is, of course, desirable, as in the case of all safety switches, that the door be interlocked with the switch handle so that the door may not be opened with the switch closed.

2. Portable cable used between motor and source of power should have an extra conductor inserted for use as a ground wire. For instance, with a three phase motor, a four conductor cable should be used.

The extra conductor should be plainly marked. It is recommended that this conductor be covered with a white braid for marking.

It is further recommended that this cable be covered with a flexible conduit, in which case the flexible conduit may be used to serve as a medium for grounding.

3. Care should be exercised in the grounding of not only the frames of the motor and generator of welding sets, but also the covers and containing cases of switch and control devices, frames of reactors and all other metal work which might become energized by the failure of insulation on cables, wires, or any part of the equipment.

4. The use of solder to fasten welding cables to ground clamps is not to be recommended. Due to the large currents and to the imperfect connection which is often obtained, resulting in heating of the ground clamp, solder is often partly or totally melted out of the lug. This results, very often, in imperfect operation and finally interrupts the operation entirely. Connection made with some form of clamping connector is more to be desired.

The Committee desires to give thanks to Mr. Robert E. Kinkead, Welding Engineer, for his assistance in preparing the cost data of this report.

Respectfully submitted,

COMMITTEE ON ELECTRIC WELDING.

Report of Committee on Power Trucks and Tractors

Interesting Observations on Battery Discharge. Pertinent Question Presented for General Discussion

Committee:—

Louis D. Moore, chairman, electrical engineer, Missouri Pacific R. R.; C. G. Winslow, assistant electrical engineer, Michigan Central R. R.; J. W. Hughes, electrical engineer, Canadian Pacific Ry.; John Carlson, chief electrician, New York Central R. R.

TO THE MEMBERS:

During the three terms preceding the current term this Committee covered items one to four inclusive of the original outline of procedure as set forth in Proceedings of October, 1920. During the current term the subject of mechanical and electrical details was followed up, as well as some practical tests and observations concerning operating features of various types of trucks. The question of a desirable repair shop for maintaining a number of electric trucks was also gone into. As regards mechanical and electrical details, requests for details of truck data were made to all truck manufacturers in the

country. This data was promptly furnished, and after being classified was distributed to the members of the Committee for tabulation and discussion. It is understood, of course, that this data is not to be used by the Committee for comparative purposes. This forms the major portion of the year's work and is still in hand, and will not be ready for submission at this meeting.

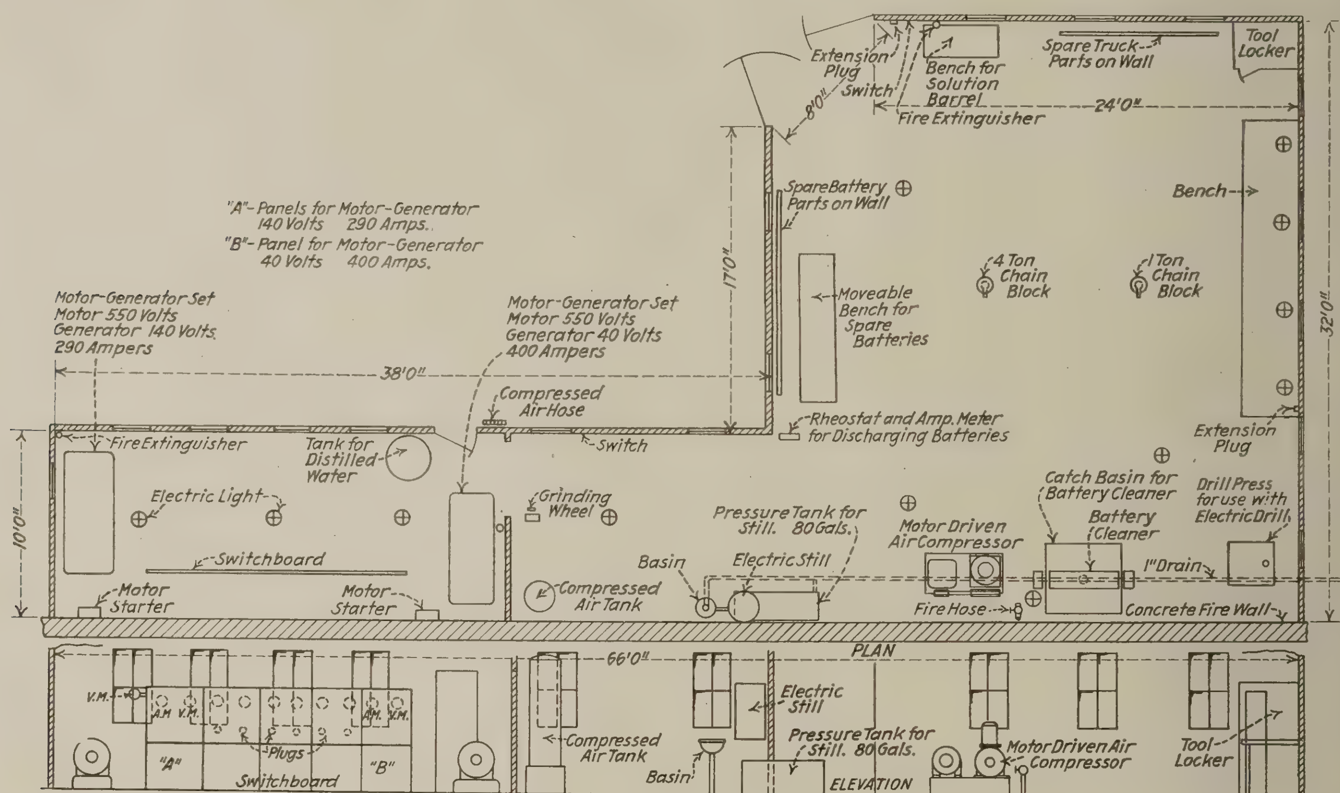
The illustration which appears in this report shows a layout of a repair shop and battery charging station which was completed recently along the lines agreed on by the Committee as a suitable layout for efficient electric truck operation. It is in use at one of the Great Lake Terminals of the Canadian Pacific Railway, where a fleet of twenty-five electric trucks and a total of thirty-three sets of twenty-one Edison type batteries are maintained.

of equipment under different operating conditions. Among the noticeable features observed, the following should be of interest:

Quite a perceptible difference in rate of battery discharge is noticed with truck running "against" and "with" the planking of wood flooring in good condition.

At one point where the grade is 16 percent and 19 feet long, the rate of battery discharge was found to be 190 amperes with the truck carrying a load of 980 lb. On the level with the same load the discharge was 80 to 70 amperes, gradually becoming steady at 60 amperes.

The average distance traveled per trip of truck was 1,000 feet and the average load 1,000 lb. Each truck makes 13.7 trips per hour. It will be seen that in this case trucks are standing for a small portion of the time as



Repair Shop for Electric Trucks

The two motor-generator sets have capacity for charging nineteen trucks at a time. The service, which consists of transporting flour in bags from the deck of the steamer to the freight shed, is very severe, due to the excessive grades created with the varying positions of the steamer depending on its load. To overcome delays arising from early discharged condition of batteries, spare sets of batteries are maintained fully charged. During a recent observation, trucks with discharged batteries were equipped with fresh sets of batteries so promptly that the average time any one truck was out of commission was forty-five seconds. As a substitute for steam which is not available for cleaning the tops of cells, compressed air is obtained by an electrically driven air compressor with storage tank and automatic motor control. Distilled water is obtained with an electric still.

To assist in making future recommendations for requirements of mechanical and electrical details, the Committee decided to carry out tests and make observations

the average speed over the entire hour is 2.6 miles per hour, including stopping time.

The following subjects are offered for general discussion:

1. In determining operating costs of power trucks and tractors, do not the depreciation and maintenance charges overlap in many cases? That is, if a machine is kept in perfect condition by occasional heavy repairs should not the depreciation be omitted?

2. To what account should new tires be charged?

3. The usual battery used with electric trucks is the Edison type A6; is not the expense of a larger capacity battery justified where trucks are used on heavy grades?

4. In large plants is it good practice to have one central charging depot, or more than one to avoid loss of time and power going to and from location of work?

5. Is the expense of equipping electric trucks with ampere hour meters justified?

6. Have the underwriters in any part of the country

any objections to using gasolene vehicles inside of buildings?

7. To avoid heavy discharge of batteries, is it the practice to make use of lifts or hauling machinery to help electric trucks over steep grades?

8. The advantages of maintaining spare sets of batteries complete in battery boxes for use where trucks are required in continual operation for a period exceeding the charge of the regular battery. What proportion of spare batteries to regular batteries should be maintained for different classes of service?

Respectfully submitted,

COMMITTEE ON ELECTRIC TRUCKS AND TRACTORS.

Testing for and Locating Grounds on Car Wiring

THE procedure outlined below will undoubtedly be of assistance to members of the electrical force who frequently have to locate and remove grounds on car wiring. This method is one of the most practical that has been developed, as by its use, the majority of grounds can be easily and quickly located.

To intelligently handle wiring troubles it is essential that the electrical repairman be thoroughly familiar with the standard wiring diagram of the cars. Such a knowledge can be quickly gained from study of blue prints, which should be available in all yards.

Instead of using a magneto, the electrical repairman should provide himself with a "ground wire" or "jumper" which can be made out of two pieces of No. 4 or No. 6 solid copper wire about 7 in. long and one piece of No. 4 or No. 6 very flexible copper wire such as a flexible lead is made from.

The two pieces of solid wire form the prods and each piece should have 1 in. at one end turned back, forming a straight hook with ⅛ in. opening, the other ends should be spliced and soldered to the ends of the piece of flexible wire. The flexible wire and joints should then be covered with a piece of cotton sleeving and the ends of this sleeving wrapped with linen thread and the wrapping then shellaced. This "jumper" makes a very useful tool, but also a very destructive one if used improperly.

When a car is to be tested for grounds proceed as follows: Close the *light* and *trainline* switches on the distributing panel switchboard (for a satisfactory test the battery voltage should be not less than 24 volts, but the trainline connectors should *not* be put up). If the distributing panel is fitted with snap or other type circuit switches they should be turned *on*. Then with "jumper" make contact between one side of light switch at a time and the ground (steel frame of car). If there is no indication of a flash or spark, the entire wiring is free from grounds and no further test is necessary, so nothing is gained by also trying for grounds on each of the lugs on panel or regulator.

If a flash or heavy spark is obtained, it indicates that some portion of the wiring is grounded. First pull the train line switch and then test again; if it then tests clear it indicates a grounded train line circuit and the ground may exist on the train line wire itself, in the female receptacles at the ends of the car, in the junction boxes, or back of the distributing panel. Such grounds can usually be easily found and removed.

If the last test indicates that the wiring is still grounded the train line is clear and the ground exists elsewhere. Then open the light switch and test again; if no flash appears, the ground is located on the interior car wiring and may be anywhere on any of the light or fan circuits from the distributing panel out. Usually one fuse plug on the defective circuit will blow as soon as the ground test is made, which clearly indicates the circuit in trouble. This blown fuse should then be removed and replaced with a reinforced plug fuse (*which is only to be left in during the test*) and all the lights on the circuit should be turned on.

The man making the test will now need some one to assist him. The first man remains at the distributing panel with the "jumper," while the second places himself in the most suitable place to watch the lights on the defective circuit. The man at the distributing panel makes ground contact with the "jumper" for 1 or 2 seconds, breaks contact for 5 or 6 seconds and keeps repeating until the assistant has finished, provided it does not take more than 8 or 10 contacts; if more are absolutely necessary, wait 3 or 4 minutes to allow parts to cool.

While the ground wire makes contact, the assistant closely watches the filaments of lamps on the circuit in question. The lamp nearest the ground will dim appreciably and in some cases will go completely out. Frequently all lamps on the circuit will dim or go out, but usually the lamp nearest the ground will change more quickly than the others.

If a complete fixture shows as above, it is easy to determine if the ground is on the fixture itself by unscrewing the fixture and holding it away from the car body without disconnecting the leads. If the fixture is grounded the jumper test will now indicate no ground. If still as before, the ground is on some other part of the circuit, frequently where the wires come out of the conduit.

This same method may be used in testing fan circuits for grounds, the grounded fan or one nearest to the ground will show down appreciably when the "jumper" makes contact.

If all lights of a circuit dim uniformly the ground will usually be found in the switch, main line or feeder of the circuit. Such cases are not as frequent as grounded fixtures.

UTMOST CARE MUST BE EXERCISED IN USING THE GROUND WIRE OR JUMPER, AS IT IS VERY EASY TO BURN OUT THE COMPLETE CIRCUIT, IF USED CARELESSLY.

The next step if the ground wire still indicates a ground, *after the trainline and light switch have been opened,* is to continue eliminating one circuit at a time. By removing the field fuse and disconnecting—G (negative generator lead) from the regulator the entire generator is disconnected from the rest of the wiring as long as the automatic switch is not closed. If the jumper tests clear now the ground is on the generator or leads and can be easily located. The armature can be disconnected from circuit by raising all the brushes, and the field coils can be disconnected at the generator terminal box. For testing these last parts—G must be reconnected.

If a ground is still indicated with the generator dis-

connected it probably exists on the underframe wiring or regulator. To test the remaining circuits the tester should either be familiar with the underframe wiring or have a blue print. All circuits except the negative charging receptacle line can be disconnected from either the panel or regulator and tested in the same manner. Sometimes grounds are found back of the regulator.

Frequently the ground will be found in the battery box, either on the leads or on the battery itself. If the battery is grounded, the ground will be found on the opposite polarity from which the jumper gives a flash. If the jumper gives a flash between the *positive side* of switch and ground, the ground is on the *negative side* and *vice versa.*

Occasionally the jumper will give a flash between each side of the switch and ground. This always indicates a battery ground as the only way this result can be obtained is by having a portion of the battery between each side of the wiring system and the ground. If the flash from each side is of about equal intensity a cell near the center of the battery must be grounded, if more of a flash on one side than the other the ground is on a cell near the terminal of opposite polarity. With a voltmeter it is possible to determine almost the exact cell by taking readings from each side of the switch to ground. Most battery grounds are due to an acid soaked crate resting against a metal part of the box, or by long connectors being caught between a crate and one of the steel partitions of the box.

Sometimes a very slight ground will be found on the battery that will barely give a spark on test. These are usually due to current leaking over insulators and through acid soaked crates, and are very hard to completely remove. If very slight they will do no harm.

Grounds that cause the most damage and trouble are those where the point of contact is sufficiently solid to carry a very heavy current. These will give a very heavy flash upon test as it is equivalent to short circuiting the battery.

Never try to locate a ground while a car is on charge, as most charging systems are grounded. Never attempt to locate a ground by this method on any kind of a system except a low voltage battery system. This method cannot be used successfully on the bell system. Use magneto for this purpose.

Too much emphasis cannot be placed upon the proper use of the "jumper," for if the ground is heavy and it is held on too long, it is possible to burn all the insulation from a circuit, to melt posts or connectors on the battery, or to burn a circuit open.

Electric Lights for Rail Motor Car

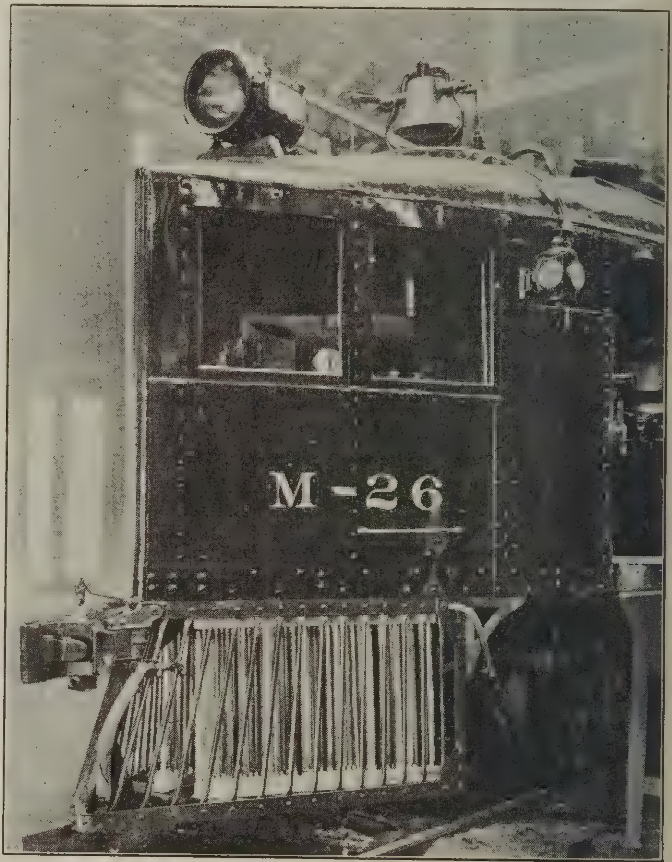
A rail motor car equipped with an automatic electric light plant was recently placed in service on the Santa Ana branch of the Union Pacific. The branch is 31 miles long and the car makes two trips in each direction per day.

The car used is a McKeen motor car which weighs 70,000 lb., is driven by a 200-h.p. (S. A. E. rating) internal combustion engine burning kerosene and has a seating capacity of 72. It was lighted originally with gas. To provide a better headlight and more convenient lights for interior lighting and for markers, a small lighting plant independent of the main driving engine was installed.

The lighting plant has the unusual feature of automatic operation. No auxiliary storage battery for lighting is used. Turning on the first light causes the generating plant to start automatically. Turning off all the lights causes the plant to stop.

The plant, made by the Kohler Company, Kohler, Wis., consists essentially of a 4-cylinder, 3½-hp. gasoline engine driving a 110-volt, 1,500-watt direct current generator.

The engine is water cooled and is of the valve-in-head type. The bore of the cylinders is 2 inches and the stroke is 3 inches. A high tension magneto is used for ignition. A small 24-volt storage battery, which is kept charged automatically, is used for starting.



Front End of McKeen Motor Car, Showing Electric Headlight and Marker Lamp

The over-all dimensions of the power plant are 14 inches by 31½ inches by 36 inches high.

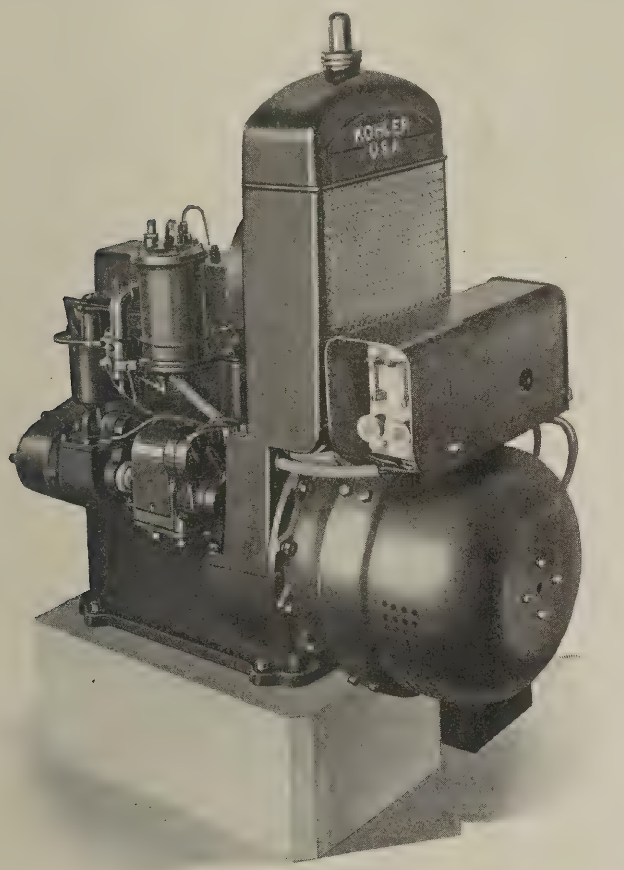
When one of the lights on the circuit is turned on, the closing of the lighting circuit actuates a relay which operates the starting switch. Under light load the plant operates at a speed of about 850 r. p. m. When the load is increased, the plant automatically builds up its speed to take care of the load. The voltage remains practically constant at all loads and speeds. This is accomplished by an electrically operated throttling governor and special windings on the generator.

The lighting units in the car consist of 50-watt lamps in Safety No. 9298 fixtures, spaced 5 feet apart

along the center line of the car. There are 13 of these units inside the car.

The headlight is an E F 1412 Golden Glow headlight fitted with a 250-watt G-30 type C clear floodlighting lamp. Ten-watt carbon lamps are used in the markers.

All circuits are controlled from switches on a panel in a metal cabinet in the operating compartment. The circuits for the interior lights are carried in rigid metal conduit along the roof of the car. A junction



The Lighting Power Plant Complete

box is placed on the roof directly over each fixture and the nipples extending down through the roof to the fixture are soldered to the roof. B X cable is used to connect the headlight and marker lamps.

To provide for emergency, a 24-volt headlight lamp is carried in the car. If the 110-volt power should fail, the 110-volt headlight lamp would be replaced with the 24-volt lamp and the circuits are arranged so that the starting battery can be used to operate the headlight. The gas side lights have been left in the car for interior emergency light.

The Game of Life

A man, who's hair was streaked with gray,
Came shuffling in the other day
And told a tale of woe.
He said that "new conceited duds,
Who should be outside digging spuds,
Were grabbin' all the dough."
"Each day, for years, he'd toiled and slaved;
Denied himself the things he'd craved
And tried his best to please—
While, all about a gang of bums,
Just loafed and plucked the ripest plums
From off the nearest trees."
He had few shekels in his jeans;
Since Hate, from him, had spilled the beans;
His soul contained no song.
He was a weazened misanthrope,
Who'd lost his goat and with it—hope.
And *everything* was wrong.

I listened to his dismal spiel,
It *seemed* he had a damn raw deal;
While sitting in Life's game,
But, when I checked his daily plays
I found inertia never pays
The halt, the blind and lame.
He never felt that cosmic urge
That makes a hustler's life-blood surge;
He'd missed that vital spark,
Which puts the job up to the front
And makes our toil a happy stunt
In sunshine and the dark.
No stimulant had stirred his soul;
He had no real objective goal;
He bubbled with the dross.
He never stopped to analyze—
His real good points—or advertise—
His efforts to the boss.
And when I looked out at these "bums,"
Who copped, from him, his rightful plums,
I found a bright-eyed crew;
Who never overlooked a bet,
For something they could justly get.
They *were* a favored few.
Because in each, a mainspring tight,
Kept both hands moving, day and night,
They swam against the tide.
They followed old Dame Nature's laws
Which states "effects come from a cause"
Which one can *often* guide.

We can't all be an "Einsteinmetz"
While, with the future, making bets
Nor all a "Thomas A."
We may not feel the sweet caress
The public gives to *great* success
But we HAVE to SIT and PLAY.
So while we're in this game of life,
Check your bets to *useless* strife;
Protect your own good name
And if you lose, for Goodness sake,
Don't sit and whine and *belliache*
And, thus, gum up the game.
If *you'll* do more in every way;
"You *will* get better, day by day";
You can fill bigger shoes
And when old age slips up behind,
You'll be surprised, just then, to find
You're worth too much to lose.

The Chicago, Rock Island & Pacific has awarded a contract to the Roberts & Schaefer Company, Chicago, for the erection of a 200-ton automatic electric coaling station of frame construction at Hutchinson, Kan.

General News Section

The Long Island Railroad has placed an order for 60 steel motor passenger cars for electric service with the American Car & Foundry Company.

The Southern Railway reports that in 1922 a total of 17,668,605 passengers were carried on its trains, without a single fatality to any passenger as the result of an accident to a train or negligence on the part of the railway.

The Alaska Railroad has been put out of business for about 100 miles, at its southern end, by severe rains, washing away sections of the road bed and damaging bridges. This is the substance of a dispatch dated October 16. No estimate of the amount of damage is given.

The Westinghouse Electric International Company has received orders for electrical apparatus to be used in reconstruction work in Japan; the total cost will be over a million dollars. Other orders are in course of negotiation which will bring the total amount to about two million dollars.

The Philadelphia & Reading Railway has awarded a contract to W. V. Pangborne & Company for outside electrical equipment to be used in connection with the new $3,000,000 terminal of the company's seashore lines at Camden. This equipment consists of transmission line, main line switches, switchboards and other material. The contract provides for the furnishing and installation of this equipment.

Specifications for Dry Cells have been issued by the Bureau of Standards as Circular No. 139. The items covered in this "United States Government Specification for Dry Cells," include types and sizes of cells used, zinc, sealing compounds, etc., and the test for voltage and performance are outlined. Copies of the bulletin may be received from the Government Printing Office, Washington, D. C., for five cents each.

Seeing a Smash-Up.—Life is too short and too sweet to take blind chances at grade crossings, when it is so easy to make sure. This is the advice of the Standard Oil Company in its advertising campaign to sell to automobilists greater quantities of gasoline. Continuing, the ad writer says: "I saw a smash once, and that was enough for me. No more taking chances for Yours Truly, or 'hoping' there isn't a train coming. You can't absolutely trust anything but your own eyes to tell you whether the track is clear or not. The flagman may not be on duty when you happen along. The automatic signal may be out of order. The train may be coasting quietly down a grade toward the crossing. There are a dozen 'mays,' and 'may nots,' and 'ifs.' No siree! My tip is: Always assume there is a train coming. It is better to be wrong than to have your picture in next day's paper—'Victim of Auto Wreck.'"

Armed bandits held up the southbound Southern Pacific Express No. 13, about 17 miles south of Ashland, Oregon, on October 11, killed three trainmen and a mail clerk and escaped with an unknown amount of loot. The robbery occurred as the train was emerging from tunnel 13 south of Siskiyou, on or near the state line. The engine was nearing the tunnel entrance when an explosion blew away part of the roof of the tunnel and caused part if it to cave in on the train. As the train was brought to a halt two men advanced to the locomotive, where they shot the engineer, fireman and another man. The robbers then went to the mail car and blew open the door with a charge of dynamite, which explosion killed the clerk and set fire to the car. The mail safe was then opened and the contents taken. The explosion shattered windows in some of the passenger cars and passengers were cut by glass.

Rock Island Observes Seventy-First Birthday

On October 10, the Chicago, Rock Island & Pacific, observed the seventy-first anniversary of its birth by celebrations at several places, the principal function being a banquet held in Chicago, on the evening of the 10th, under the auspices of the Rock Island Club, of which L. F. Shedd, general supervisor of safety, is president. This dinner, which was held in the Florentine room of the Congress Hotel, was attended by about 200 officers and employees including Charles Hayden, chairman of the board of directors; J. E. Gorham, president M. L. Bell, vice-president and general counsel, and Hal Ray, director of the newly created department of personnel and public relations, all of whom made short talks. The remainder of the evening was devoted to an informal dance in the Sherman Hotel. Music at both the dinner and the dance was provided by the Rock Island Orchestra, an organization of about 25 pieces. Earlier in the day a reunion of the pensioned employees and their families was also held at Chicago. It is the plan to conduct similar celebrations every year.

New Bulletin on Sulphation of Storage Batteries

"A New Method of Determining the Rate of Sulphation of Storage Battery Plates," is the title of bulletin No. 225, issued by the Bureau of Standards recently, which was prepared by G. W. Vinal, physicist, and L. M. Ritchie, associate chemist. This paper describes experiments which have been made to develop a speedy and accurate method for measuring the effect of impurities in storage-battery electrolyte. Because of the inaccuracies of the method previously used and the time required to complete the experiments it was decided to determine the effect of impurities in terms of the rate of the reaction taking place at the plates. This may be determined accurately in a short time by successive weighings of the plates immersed in solutions which are maintained at constant temperature. The plates were suspended in the electrolytes from the arm of a sensitive balance. By this arrangement it is possible to weigh each plate without exposing it to

the air. The reaction at the negative plate may be both chemical and electrochemical; the measurements show that the former predominate. The rate of sulphation of the negative plates increased as the concentration of the electrolyte and the temperature were increased. The rate of sulphation of the positive plates is much less than for the negative plates. Corrections for the buoyancy of the electrolyte are necessary. It is possible to compute from the electrochemical equivalents the number of ampere-hours of discharge occurring as local action.

Illinois Central Moves Large Office Building

What is said to be a new record in moving large buildings was established this week in Chicago when a seven-story brick office building of the Illinois Central, 80 ft. by 130 ft. and weighing 8,000 tons was moved 90 ft. to provide for street widening incident to the terminal improvement work being done by that company in that city. The aged condition of this building, its proximity to one of the main heavy traffic boulevards of the city; and the presence of water in the excavation, which was carried to clay 1½ ft. below the level of Lake Michigan (adjacent) complicated the problem. The building was carried on a grillage of steel beams supported on rails and was moved without mishap, being transferred 40 ft. in one day.

P. R. R. Extends Electrification

The Pennsylvania Railroad Company has started work on the electrification of its Whitemarsh Branch which extends from Allen lane station on the Chestnut Hill branch to Whitemarsh station. The branch is six miles long. It is expected the first electric trains will be in operation about the first of the year.

The light traffic which moves over that branch will be handled more efficiently and economically by the electrified service than by the steam trains now in operation.

C. & N. W. to Celebrate Seventy-Fifth Anniversary

The seventy-fifth anniversary of the Chicago & North Western was celebrated in Chicago on October 24, when the officers of the railway had as their guests for the day 100 veterans who had been in active service for 50 years or more. These veterans representing all branches of the railway service were brought to that city as guests. They were tendered a luncheon in the passenger terminal by the Chicago & North Western Women's Club and taken on an automobile tour of the Park and boulevard system of Chicago, the day ending with a "get-together" and good fellowship dinner at one of the principal hotels. The Chicago & North Western is the pioneer road of the West, the old Galena & Chicago Union having been the first railroad to lay tracks west of Chicago.

Census of Electric Railways

The Department of Commerce, Washington, has issued a compilation relating to the miles of line operated by electric railways in the United States in 1922, as compared with 1917 and 1912. These figures do not include electrified tracks of steam-railroads. The length of road operated in 1922 aggregated 43,934 miles as compared with 44,808 miles in 1917, a decrease of 2 per cent, and 41,033 in 1912, an increase of 7.1 per cent for the 10-year period. The figures show decreases in mileage in 32 states and small increases in 16 states in 1922 as compared with 1917. The most important losses of trackage occurred in Massachusetts (366 miles) and Ohio (260 miles).

Annual Dinner of New York Railroad Club on December 6

The New York Railroad Club will hold its fifth annual dinner at the Hotel Commodore, New York, at 6.15 p. m. on December 6. Reservations may be made until November 24 by application to H. M. Norris, secretary to the president, Interborough Rapid Transit Company, 165 Broadway, New York; subscription price, $5 a person.

Secretary Hoover Calls Super Power Conference

A super power conference was called by Secretary Hoover in New York on October 13. The purpose of the super power development is to provide better and cheaper electric power for industries, homes and railroads in the New England and Middle Atlantic States. Mr. Hoover took pains to state that the conference is not conceived as more government in business. He said, "The public authorities are already deeply in the power business through many forms of regulations and a very large measure of control of power sources. The thought here is that co-ordination between public authorities and industries may secure further consummation of a great advance in the development of great service to the public.

"There are time-honored disputes over states' rights with regard to water and somewhat similar questions are being raised as to power. It is not probable that an embargo could be constitutionally placed upon power flow across state frontiers but unco-ordinated legislative and regulative actions by the states and national government might amount to economic embargoes and discriminations and thus stifle development. The projected water power development of the St. Lawrence river which would provide the United States with about 1,200,000 hp. can only be consummated by co-operation of the federal government." It is problems like these that Mr. Hoover feels should be worked out by the super power conference.

With regard to railroads, Mr. Hoover says, "With the crowding of our population in large areas, we are faced with most difficult questions in the development of terminal facilities, the handling of traffic on our railways. There has been some electrification of transportation. The engineers who have made systematic super power surveys are convinced that over 40 per cent of the mileage of the railways in this territory could be electrified at substantial economies in operation and with enlarged service if we should secure this greater and more economical power development."

Mr. Hoover also says, "The economical distribution of power rests, to a large degree, upon local territorial monopoly. Competitive overlap of power distribution systems would represent tremendous capital and distribution waste. I am not here to advocate federal super regulation of interstate movement of power. I believe that power development and distribution would find its greatest solution in co-ordinated and state regulation, perhaps with assistance and co-operation of the federal government, rather than in any superstructure of authority such as has been found necessary in transportation unless, of course, necessities of the case cannot be attained otherwise."

The state officials, consisting of representatives of public service commissions and engineers, who were present at

the conference, expressed approval of the general plan and while disclaiming any intention of speaking for the legislatures of their respective states, promised to co-operate.

I. C. C. Denies Petition to Inspect Automatic Train Control Installation

The Interstate Commerce Commission has denied the petition filed by the Pennsylvania asking the commission to make an inspection and test of the automatic train control installation on its line between Sunbury and Lewiston, Pa. The commission now has a fixed policy of not making any further inspection or tests on any of the 49 roads named in its train control order. These roads are required to complete their installations over a complete engine division by January 1, 1925. The commission takes the position that the period between the date of the train control order and January 1, 1923, was expressly for such tests as the carriers might desire to make, preparatory to making their selections; and that the two-year period, January 1, 1923, to January 1, 1925, was provided in accordance with the law in which to make the actual installation. The commission has taken the position now that it will not pass on any installation until a complete engine division has been equipped in accordance with order, as compliance with the order depends upon proper installation and maintenance, and not merely on the device itself.

Extent of Earthquake Damage to Japanese Railways

The New York office of the Japanese Government Railways has received the following information by cable concerning the extent of the damage done by the earthquake to its railway lines:

The head office, the government railway hospital in Tokio, the government uniform manufacturing shops in Tokio, the government lumber creosoting plant in Tokio and the following stations were all destroyed: Shimbashi, Manseibashi, Iidamachi, Ueno, Ryogoku (all in Tokio), and Sakuragichi (in Yokohama, the terminal of the electric line between Tokio and Yokohama.)

The Tokaido Line, east of Hakone and around Tokio was seriously damaged. Officials and employees' residences at Shiodome, near Shimbashi, Ueno and Ryogoku were entirely burned down, but no casualties resulted among the chief officials.

The losses also include the burning of 416 passenger cars, 31 electric cars, 893 freight cars, and 33 locomotive engines.

I. C. C. Reports Favorably on Miller Train Control

The Interstate Commerce Commission under date of September 21 has made an engineering report on the plans and specifications of the Miller train control system in the form of a letter from W. H. Harland, chief of the block signal and train control section of the commission, which renders a favorable opinion on this device.

The report states that the plans and description of the device have been given careful consideration and after outlining the description, concludes as follows:

"From the examination of the plans submitted, it is our opinion that if properly constructed, installed and maintained, this device will operate as intended."

The plans and specifications reported on are those of the device as installed on an entire engine division of the Chicago & Eastern Illinois, where it has been in regular service operation for the past nine years, with the exception that they include a positive stop attachment which dispenses with the permissive feature and provides for an absolute stop, and also an additional feature in the form of reversing mechanism which gives protection in either forward or backward movement.

Personals

H. A. Wilson has been appointed manager of the Detroit branch of the Gibb Instrument Company, Bay City, Mich., succeeding F. M. Luchs, resigned. Mr. Wilson was formerly district manager in New York for A. P. Munning & Co.

Erich G. Elg has been appointed office and sales engineer for the Steel Sales Corporation, Chicago, Ill.

Mr. Elg was previously employed by the Chicago surface lines where he had charge of tests in the shops and equipment division and was associated in new car construction. Previous to this he was operating engineer of the Decatur Railway & Light Company, and Illinois Traction Company. Mr. Elg is a graduate of the School of Electrical Engineering, University of Illinois. In his present work, he will handle the products of the Copper Clad Steel Company.

Trade Publications

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., is distributing an illustrated folder showing the various applications which may be made of the electric hoist which it manufactures.

Motors.—The Reliance Electric & Engineering Company, Cleveland, Ohio, has issued at 32-page booklet on its Type T heavy duty Reliance direct current motors. The booklet includes a detailed, illustrated description of how the motors are built, tables of ratings, general outline dimensions and a large number of illustrations showing motor applications.

Portable Cord and Cable.—The Rome Wire Company, Rome, N. Y., has issued a 20-page booklet, entitled, "Super Service Cord and Cable." All of the various sizes of this type of cord and cable manufactured by the Rome Company are catalogued and the characteristics of each, including the outside diameter, allowable capacity in stranding and gage, are given. The uses for which this type of wire is particularly suited are illustrated.

Thermit Rail Welding.—The Metal & Thermit Corporation, New York, has recently issued a 72-page, illustrated pamphlet devoted to recent improvements in thermit rail welding. The text includes detailed instructions accompanied by illustrations, for the making of rail welds by the improved method. The apparatus used in conjunction with rail welding as, for instance, a self-luting mold box and a light-weight double-burner preheater are described in detail. Other instructions are included covering the use of thermit for welding compromise joints, constructing frogs and crossings and for repairing loose arms of gates and switches. In addition to the above, the pamphlet contains data on rail bending and drop tests.

Railway Electrical Engineer

Volume 14 DECEMBER, 1923 No. 12

The fourteenth annual convention of the Association of Railway Electrical Engineers, held at the LaSalle Hotel, Chicago, November 6 to 9, was undoubtedly the most successful convention in the history of the association. Starting from a comparatively small group, whose interest was almost exclusively car lighting, the Association of Railway Electrical Engineers has increased its membership year after year and its influence has grown in proportion so that today it embraces not only car lighting problems, but practically every application of electricity to the steam railway field. It is also interesting to note that with the growth of the electrical applications, the men themselves have grown in like proportion, so that today men who were previously occupied with only the electric lighting of cars have become in every sense electrical engineers with broader scope for their activities and keener vision for the future possibilities of the use of electric energy in railroad work.

Electrical Engineers' Convention

A most significant fact was brought out early in the discussion, and was continued throughout all of the sessions, and this was the comparative savings possible with the introduction of electrical equipment. In fact, it might well be said that the dominating note of the entire convention was economy.

The members are alive to the possibilities that are to be secured through a more extensive use of electric energy, but unfortunately they have been so extremely busy with the maintenance and installation of electric equipment that they have overlooked a very important factor. The electrical engineers have not presented their ideas to the managements in a way that has caused the latter to become enthusiastic advocates of electric equipment in all places where it can be used to advantage. Too much attention has been given to the engineering side of the work and not enough to the gathering of cost data. For this reason, the electrical men are unable, in many cases, to show the actual savings possible by the installation of certain devices. This was very clearly brought out in the discussion.

To bring about the general application of electrical equipment, in all of the places where it is desirable, it is most important that actual costs and savings be shown in concrete terms; where this has been done, the support of the managements has been obtained. This particular lesson of the convention was so fully appreciated by the members that it is more than probable that marked results will follow during the next year.

That the scope of the association is steadily increasing is indicated by the presentation of three committee reports on subjects which are new to the field of electrical work on the railroads. One of these dealt with the progress that has been made in the development of self-propelled rail cars. There appears to be an increasing demand for cars of this type in the branch line service of nearly all roads and this demand, coupled with the improvements that have been made in this equipment, presage still further increase in the utilization of rail motor cars. With the introduction of these cars, the electrical forces will be depended upon for maintenance of the electrical equipment, the amount of attention required varying from a minimum on the straight gasoline motor cars to a maximum on the storage battery and gas-electric cars.

Another subject which seems to hold possibilities for the future was that of the application of radio to moving trains. As yet, all that has been done in this connection has been of an experimental nature, but with the rapid progress which radio has been making in other fields, there is little doubt but that it will find an important place in train operation in the future. In the light of what has already been accomplished, it is conceivable that much more will be learned in connection with this new art which will inevitably tend toward simplicity of design and reliability of performance. When this stage arrives, there is no question but that radio will take its place in railroad operation.

A third report and one which is decidedly pertinent to present conditions was that of automatic train control. This subject bids fair to require the very best that the electrical engineers can give in the way of thoughtful study. Train control must be applied on many roads during the next year and embodying as it does, the coordination of the wayside signal systems and electrically operated air brake equipment on the locomotive, it will give the electrical men ample opportunity for the exercise of their best talents.

Another significant feature of the convention was the unusual number of new members enrolled. The constantly increasing importance of the problems which are confronting the electrical men tend to draw them together in a stronger alliance. There is no longer any question but that electrical equipment is finding its way into every department of steam railroading and as this growth increases from year to year, the Association of Railway Electrical Engineers will grow correspondingly until eventually it will take its place as one of the most powerful influences in economical railway operation.

Status and Progress of Fusion Welding

At a recent meeting of the American Welding Society, one of the members outlined the uses to which the different methods of fusion welding could be put to best advantage. He stated that the cost of electric welding was in general cheaper than when the same work was done with gas and that the electric arc could be used economically for cutting steel shapes less than six inches in thickness. He also said that the use of studs in connection with the electric arc for welding cast iron was losing precedence in favor of gas welding with an iron, bronze or monel metal rod. For accurate cutting, particularly of heavy shapes, he said, gas is the only method to be considered. Thermit welding, he said, has its place in the welding of heavy sections and for pipe up to six inches in diameter. Similarly, he went on to say that spot welding and resistance welding each has its place, that there is only a little overlap among the various processes, and that there is plenty of room for all processes in the rapidly developing field of fusion welding.

Manufacturers of apparatus for all processes of welding were in attendance at the meeting and they were unanimous in expressing their approval of the speaker's remarks. This attitude among the manufacturers is one which makes for progress and if it can be maintained every one concerned will profit.

It is true that the manufacturers of gas welding equipment can better afford to render service in the field than can the manufacturers of electric welding equipment. The reason for this is that the sale of the gas will in part at least cover the cost of service. Because of this condition, development of the use of electric welding has been left largely to the electrical men on the railroads. The railroads have long been at the head of the procession in the use of welding as applied to repairs. If the railroad electrical man will continue to foster electric welding, at the same time retaining the generous and open mind of the speaker before the welding society, he will render a real service to the art of welding.

Flood Lighting in Railroad Yards

Recent installations of flood lighting equipment have been the means of bringing the subject of proper illumination of railroad yards into the foreground. There is no escaping the fact that good lighting of classification yards is one of the most vital factors in expediting the handling of cars. At present, there are a number of conflicting opinions regarding the correct lighting of railroad yards, and while flood lighting in some localities seems to fulfill all requirements, in other localities it is not looked upon with the same degree of approval. Some engineers claim that the glare which is caused by the lighting units when the car riders are obliged to face them is detrimental to good operation. Others claim that the best results are to be obtained by a silhouette effect.

Whether lighting units should be located so as to give illumination up and down the tracks or whether they should be placed so as to give cross illumination is a question that apparently only time can be depended upon to give the correct answer. The fact is that a railroad yard full of cars is about the most difficult illuminating problem that can be met and only by continued experimentation will the correct solution be arrived at.

Train Control Looms Up

Of all of the problems which confront the railway electrical engineers today, there is perhaps none that will call for more careful thought than that of train control. At least one division on each of 49 roads must be equipped with some approved form of train control before January 1, 1925, and in view of the large number of train control systems available, it is evident that many different types of this equipment will go into service. In one way this is a good thing for it gives the best opportunity for determining the merits of the several systems; but on the other hand, it is a condition which makes the work harder for the reason that an exchange of ideas between engineers using different kinds of apparatus is of limited value. In other words, the experience of one engineer will not benefit another to the same extent as would be the case if the same type of train control equipment were universally used. It will be interesting to watch the manner in which this train control situation is worked out during the next year, for it is certain that with the various systems in use on the different roads, the electrical engineers are going to be very busy in taking care of their part of the work.

New Books

Armature Winding. By David P. Moreton. 185 pages, illustrated, 7x5 inches, bound in fabrikoid. Published by American Technical Society, Chicago. Price $2.

This book sets forth in clear, simple language, modern practice in armature winding, and explains the theoretical principles involved. The book is intended for beginners and practical electricians and is especially planned for self-instruction.

Elementary Principles of Lighting and Photometry. By John W. T. Walsh. 220 pages, illustrated, 9x6 inches; bound in cloth. Published by E. P. Dutton & Co., New York. Price $4.50.

This book aims to provide a simple guide to the solution of the problems most commonly met with in lighting engineering and to give both an explanation of the faults which experience has shown it necessary to avoid and of the means available for the attainment of a satisfactory result in any given case. The book is intended for electrical and gas engineers, architects, factory managers and others called upon to consider matters of illumination, rather than for specialists in this field.

Welding Encyclopedia. Third edition, compiled and edited by L. B. McKenzie and H. S. Card. 438 pages, illustrated. Published by the Welding Engineer Publishing Company, Chicago, Ill.

The third edition of the Welding Encyclopedia includes a new chapter on the training of operators for both electric and gas welding. The outlines of the two courses of training make possible a systematical and logical study of each of the processes. At the same time, these outlines will also serve as a guide to the various classes of welding information which are found in other portions of the book. The extensive development which has been made in the welding of tanks and pipes is also treated and a number of large plates give details and specifications of typical constructions. The number of welding jobs giving details of preparation and handling of the work has been considerably increased. By the addition of these several sections, the book has been brought up to date and becomes of increased value to all those interested in the welding art.

"And, lo, the star, which they saw in the east, went before them till it came and stood over where the young child was.
"When they saw the star, they rejoiced with exceeding great joy." Mat. 2. 9, 10.

Fourteenth Annual Convention of the A. R. E. E.

Meeting of Electrical Engineers Draws Record Breaking Attendance of Railway and Supply Men

THE fourteenth annual convention of the Association of Railway Electrical Engineers held at Hotel La Salle, Chicago, November 6 to 9, will go down on the records as the most successful convention that the association has ever held. Every session was well attended, and much interest was manifested in each report. Many new members were added to the roster, some of these coming from roads that heretofore had no representatives, while a large percentage of the new men came from Canadian roads.

Not only were the convention sessions well attended but the exhibit of the Railway Electrical Supply Manufacturers' Association, held in an adjacent room, was crowded to capacity, until at times, the aisles became almost impassable. As a matter of fact, there was insufficient space to provide for all who desired to exhibit.

The first session of the convention was called to order at 10:00 a. m., November 6, by the president, E. S. M. MacNab of the Canadian Pacific Railway, who addressed the convention as follows:

"It is with much pleasure that I welcome you to the fourteenth annual convention of the Association of Railway Electrical Engineers. These conventions are a source of profit to both the individuals who attend and to the companies which they represent, as they enable the various members to become personally acquainted and lead to an interchange of experiences.

"The electrical field on our railways still continues to grow, in every department the use of electricity is essential to its functioning properly. Our railways are being called upon daily to handle more traffic, to move it with greater expedition and to operate more economically. Since the war, the costs of all commodities have risen, and in some cases, to an alarming extent, without an equal increase in rates of transportation, for the railways like the manufacturers cannot increase their selling price as their manufacturing costs rise. It behooves each department, therefore, to use every effort to increase the efficiency of the railroad as a whole. In this, the electrical department has done its share and further opportunities await its efforts, but it is only by each member concentrating his mind on his own individual problems and seeking the best solution, that the best aggregate results be obtained.

"The committee reports which will be presented to you, have all been carefully prepared and represent considerable effort on the part of the committee members. The subjects are all practical ones and deal with problems to be encountered in our every day work. I would, therefore, commend them to your deepest interest and more especially I would ask for a very full discussion on each report. At this convention, three new subjects—automatic train control, rail motor cars and radio experiments on moving trains, will be discussed, and although the subjects are new in the railway service and also come within the purview of other departments and associations, this association should keep in the forefront and in cooperation with others to assist in their development.

"The exhibits enable us to inspect the latest developments in each line, and have the operation of devices explained to us by representatives of the various companies. Full use should be made of this opportunity and, as in past years, the afternoons are left free so that each member may have ample time to inspect the exhibits and make a thorough study of them.

"I wish to extend a special welcome to all new members, and hope they will join in the discussions.

"In closing, I want to thank the officers and chairmen of committees for their cordial assistance, and also the executives of railway electrical supply manufacturers association for their co-operation in making arrangements for this convention."

Following the address of the president, the report of the secretary-treasurer, Joseph A. Andreucetti, was presented, which clearly indicated the excellent financial status of the association. In the following paragraphs an abstract of the discussion of the various reports is given.

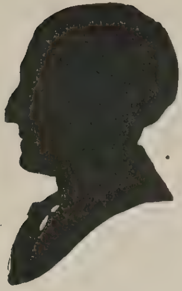
Data and Information

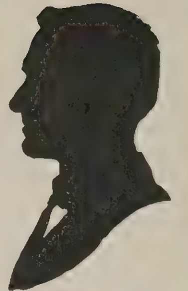
The first committee report was that of data and information. The report was presented by E. A. Lundy, *Railway Electrical Engineer,* who was chairman of the committee. After reading the report, Mr. Lundy spoke as follows: "On account of the information we had from previous years not being up to date in all cases, we picked out a number of representative roads which would tend to typify the roads as a whole. They are listed according to mileages."

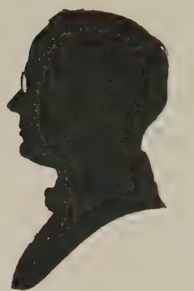
D. J. Cartwright (Lehigh Valley): "Mr. President, I would like to call attention to a purely typographical error. I notice that the Lehigh Valley Railroad is credited with 1,035 charging plants. As a matter of fact the 1,035 go over to the next column indicating that we have got that number of locomotives. Then again, turning to table five under industrial trucks in the master sheet you have the letter *D* which refers to 14 tractors and 134 trucks, but in table five there is no mention of the fact that we have 162 industrial trucks on our road, and when you come to analyze table five you will find that on the P. & L. E., 256 miles and 31 trucks, the percentage of trucks to the mile is about thirteen. On the Lehigh Valley that percentage runs about 11.1. I have not figured out the Pennsylvania, but they have the largest number of trucks on any one road in the aggregate, but you will notice that also on other roads the percentage of the number of trucks to the mile is less than one per cent."

Mr. Lundy: "In analyzing this report, we will find some roads that are well equipped with say pumping and coal stations and others well equipped say with electric welders, and that to my mind tells an interesting story."

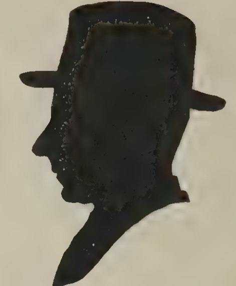
E. Marshall (Great Northern): "I think there is an interesting point that might be discussed in the tabulations in the matter, for instance, of electric welding. Some roads have a large number of electric welding units in service, others have very few, and that applies to roads that are more or less on a par as to mileage. Our road

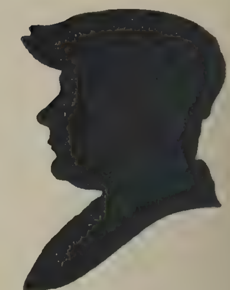

A. E. Voigt
Car Lighting Engr.
A. T. & S. F. Ry.
Topeka


W. L. Noll
Electrical Engr.
A. & W. P. R. R.
Montgomery, Ala.


J. L. Parker
Chief Electrician
A. C. L.
Waycross, Ga.


Chas. R. Sugg
Elec. Engr.
A. C. L.
Wilmington, N. C.


L. C. Muelheim
Ch. Headlight Supv.
B. & O.
Baltimore


J. H. Smeltz
Headlight Supv.
B. & O.
Cincinnati

has two. Now, I would like to bring up this thought. Is it hard or is it easy to get over these ideas with our management? How much of the labor saving electrical equipment on these various railroads has been put there due to our recommendations and our efforts? How much of it has been simply handed to us to take care of after it has been provided for us?"

Mr. Lundy: "We might start out in this way: Those people who are in charge of our railroads today in almost every case have come up through the ranks, or through the various departments, and it has been impossible for those men to think in terms of electrical application. Now that is a great problem. When you get to talking about the dollar mark your boss will listen to you, and I think we electrical men should have that in mind, because you have hundreds of electrical applications that mean a decided saving in dollars and cents."

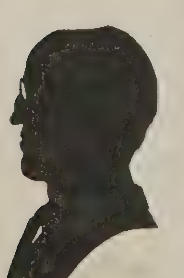
J. A. Andreucetti (C. & N. W.): "I think today the tendency of the railways, speaking generally, is to go largely to electrical appliances for all kinds of motive power except perhaps the movement of trains. It has been my experience particularly during the last year on several railroads in the west that there have been more electrical applications than there have been perhaps in seven or eight years past. That would go to prove that the railways have awakened to the fact that electric power is economic power and that electrical equipment is economic equipment and that they are going to it as fast as the money will let them get to it, and I think that the Association and the *Railway Electrical Engineer* has had a great deal to do to bring about that condition."

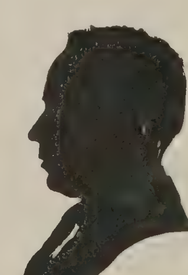
The President: "Mr. Wanamaker, you wanted to speak."

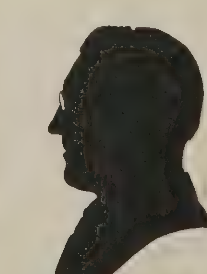
E. Wanamaker (Rock Island): "I did not want to, but I cannot help it. I know how many of us feel but do not say always right straight out from the heart. We like to gloss it over and make it sound a little better. On the other hand the progress has been great and, as Mr. Andreucetti said, much of it no doubt has been due to the work that has been done by this Association, which has been constantly widening its field and increasing its value to the railroads and their owners and their patrons. However, it seems that the engineer to be a success must be an economist. I think all engineers, and more especially the electrical engineers, have not proved themselves the economists that the civil and mechanical engineers have. The electrical part of it is comparatively a small part, though nevertheless a vital part, but management can only be interested in the economics of the railway as a whole. It would be impossible for a manager to be interested otherwise. There is another thing that I made a note of and I am afraid I will forget it unless I mention it now. It does seem that we ought possibly to have a committee eventually to function in this Association on the subject of safety and prevention of accidents in connection with electrical equipment. It is becoming so universal that I feel that we should do that."

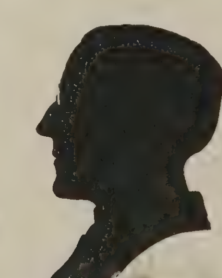
L. S. Billau (B. & O.): "I have often wondered how many of us in preparing estimates on projects feel that we have done our duty after we have worked, how much it cost to put some electrical device in and let it stop there, and wonder why it is turned down. Before you can sell your idea you must have a bird's-eye view of what this project is going to do for the railroad, not because it happens to be an electrical device, but whether it represents the most economical and satisfactory way of doing it."

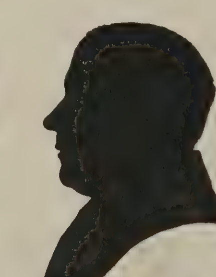
Mr. Sugg (Atlantic Coast Line): "The idea just brought out by Mr. Wanamaker and Mr. Billau is very strongly exemplified in some recent experiments or rather studies that I had to make on our own roads. One of the electric welding salesmen was very anxious to make a sale. He wrote a long letter and told how much they

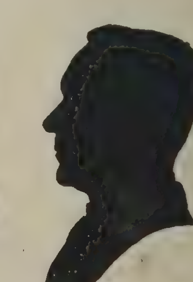

W. E. Buckmaster
Ch. Electrician
B. & O., Chicago

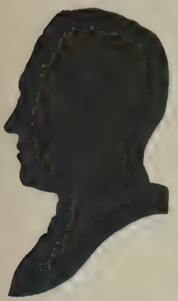

L. S. Billau
Asst. Elec. Engr.
B. & O., Baltimore


G. A. Voelkner
Elec. Engr., Belt Ry.
Co., Chicago

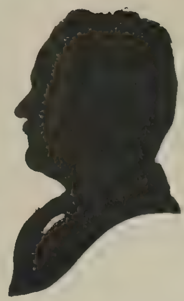

E. R. Mertz
Ch. Electrician
B. & L. E. R. R.
Greenville, Pa.


P. J. Callahan
Supr. Car & Loco.
Lts., B. & M. R. R.
Boston

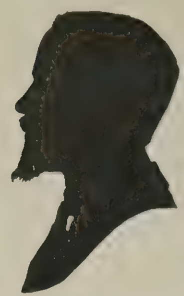

E. J. Kelly
Traveling Electrician
Canadian Nat. Rys.
Toronto



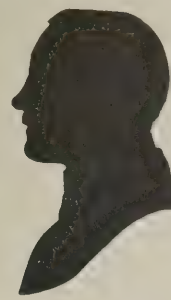
H. Kitchen
Electrician
Can. Nat. Rys.
Winnipeg



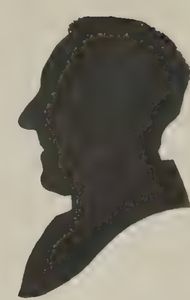
J. W. Johnston
Ch. Electrician
Can. Nat. Rys.
Toronto



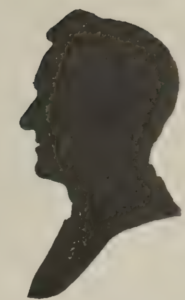
E. B. Walker
Ch. Elec. Engr., Elec.
Lines, Can. Nat. Rys.
Toronto



G. Salmon
Inspector
Can. Nat. Rys.
Winnipeg



E. S. M. Macnab
Car Lighting Engr.
Can. Pac. Ry.,
Montreal



J. T. McConnell
Electrician
Central Vermont R. R.
St. Albans, Vt.

could save and how much they could do. The general superintendent of motive power handed the letter to me and said: 'You had better get in touch with him and see what we can do.' We went over to one of our shops and laid out the work that could be done both by the acetylene and the arc welding process equally as well. We took the same amount of work, gave it to the mechanic and told him to go ahead and do that work as he usually did, first with one and then with the other. The result showed that there would be a saving of several thousand dollars in twelve months that could be effected by the use of the electric arc weld in place of the acetylene weld on jobs where either could be used. As a result I think that in the next year or two that instead of having ten arc welding units we will probably find them increased to about twenty or twenty-five."

Mr. Frazee (Duluth, Missabe & Northern): "I would like to make an inquiry if any of the members here have carried on any investigation to determine the amount of compressed air that would be required to draft a locomotive as compared with the number of pounds of steam to do the same work. This problem comes to me electrically for the reason that we buy power from the power company and drive the compressor for this job electrically."

Mr. Hagensick (Union Pacific): "It occurs to me that the whole problem in this case is the price of your energy for making compressed air. It costs lots of money to make compressed air unless you get your energy in the neighborhood of a half a cent."

Mr. Earl (T. & N. O. R. R.): "It won't pay you to do it if your energy costs you more than nine mils."

WEDNESDAY SESSION

Power Trucks and Tractors Report

The first report on Wednesday was that of power trucks and tractors which was presented by C. G. Winslow, Michigan Central. Mr. Winslow opened the discussion as follows:

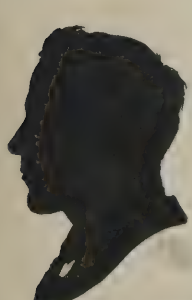
Mr. Winslow: "I might add that where the trucks are in constant use there is considerable need of spare batteries. There is the economic question that we discussed yesterday which has to be figured out in each case by itself."

The President: "It was my good fortune to be present at tests made at Port McNicoll on the Canadian Pacific Railroad at the Great Lakes steamship terminal last summer. They had twenty-six trucks in service and they had about twenty-six truck handlers or drivers. If you had all hand trucks there and attempted to move all that freight by hand, instead of having twenty-six truck drivers you would have had to have about one hundred and twenty men at least with hand trucks. This truck question is one which a great many railroads do not give the attention that it should receive. The trucks are often purchased by superintendents, by freightmen, by baggage people without ever consulting the mechanical or electrical forces at all. When they are installed they are put down in the freight shed to run until they stop and no provision made for the overhauling, maintenance or repair of these trucks. There is no piece of machinery that will last indefinitely without proper attention, and the function of this committee is to educate the railroads to put in proper facilities and to organize proper forces to make proper repairs and keep them in proper condition."

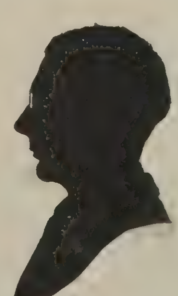
Mr. Marshall: "I would like to ask if these trucks on the Canadian Pacific were lifting trucks or were they tractors."

The President: "They were the ordinary freight handling trucks without the lifting platform."

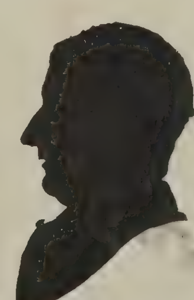
Mr. Marshall: "Would you consider this low platform type of truck to be as efficient in that kind of installation as the lifting type with the skids?"



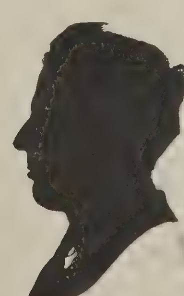
G. W. Bebout
Elec. Engr.
Chesapeake & Ohio
Richmond, Va.



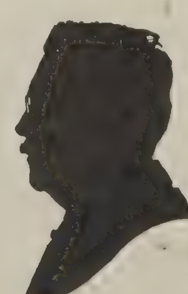
J. H. Burchman
Ch. Electrician
C. & E. I.
Danville, Ill.



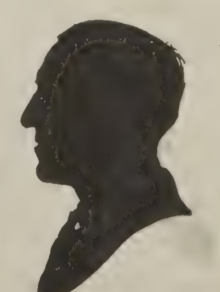
Geo. R. Shirk
Chief Electrician
Chicago & Great
Western Oelwein, Ia.



R. Daniels
Foreman Car Ltg.
C. & N. W.
Chicago



A. J. Farrely
Elec, Engr.
C. & N. W.
Chicago



Wm. Chapman
Electrical Inspector
C. & N. W.
Chicago

The President: "Oh yes, undoubtedly, because for that particular work 99 per cent of the business of those trucks is hauling flour from the lake steamers to the railhead at the port, and you have no special need of lifting."

Mr. Marshall: "In my own experience we have a few warehouse trucks for service around stores and shops. They are with one exception the lifting type. Now on the economic side of the discussion of trucks, it seems to me that there is nothing that requires any more study as to the adaptability of types than with the electric trucks. Wherever we have these in stores or shops we have skids and the lifting type of truck. They work out very nicely. Wherever we have use for tractors, however, the management has always preferred the gasoline tractor because they have a much longer range."

Mr. Billau: "Gentlemen, there is one phase of the truck problem that I think an electrical engineer can and should play a very prominent part in. The installation of any special labor saving equipment in general may prove economically very satisfactory or it may prove the reverse. I feel in many cases there has been a misapplication of the type of trucks and they have turned out to be a failure which is one of the reasons why the use of electrical trucks or similar equipment have not progressed as rapidly as many of us would like to see. In most of our recent purchases of trucks of the platform type, we have had the battery mounted above the platform at the front end of the truck, which arrangement appears to be very desirable from the operating and maintenance point of view. Most of the trucks today have a battery box that will take only the low type of battery. We have insisted in all recent trucks that the battery box be made large enough to take care of the standard car lighting batteries, and our future practice will be to use car lighting batteries. The question of the power plant and drive, in my estimation, is even more important than the electrical features. We have found that a very large proportion of our maintenance difficulties come from the mechanical features of the construction and we are giving a great deal of thought to the design of our trucks with respect to reducing maintenance to a minimum."

T. F. Foltz (Washington Terminal): "We have at the Washington Terminal thirty of the twelve foot straight frame baggage trucks in use for handling baggage and mail. The trucks are equipped each with twenty cells of Edison A-6 battery. These trucks are used practically all of them throughout the day, but on account of the light load at night we are able to take half of them out of commission from eleven to three for charging and the other half from three to seven in the morning, which makes it unnecessary for us to carry any additional batteries. These trucks are charged three in series on a 120-volt d. c. circuit. We find this most economical. Other requirements about the station call for that voltage so that it would not be an economical proposition to put in a separate and low voltage charging plant. We do not figure on any depreciation in the account. Therefore when a truck is taken out of service for being demolished or being worn out it is charged off and a new truck is charged in on an expense basis. Tires are charged in with the maintenance with the truck just the same as any other repairs. We find that the A-6, Edison battery, is of sufficient size to handle all of our work. We have very few grades and there are only two or three trucks that are assigned to that particular work, going up these grades which probably run five per cent. As a rule we have no trouble making the grade. Relative to having one set of charging appliance, in our particular case we have just the one plant. It would not pay to have another. In fact, we do not have enough territory to cover to justify another plant. Ampere-hour meters may be justified in some trucks but I know they would not be in our case. We find that the trucks get sufficient charge and where one truck may be used a little heavy the porter does not hesitate to turn it in if it begins to play out on him, and that is as good an indication of keeping the trucks properly charged as any we have found so far. We have not had any trouble at any of our points of operation that require any auxiliary means for moving a truck. In fact, our trucks quite regularly will haul two or three hand trucks as trailers. We find it unnecessary to maintain several sets of batteries on account of the traffic conditions permitting the taking of trucks out of service sufficiently long to charge each day. Where a battery may be out for some particular reason, as a rule we have, another truck out of service for a day or so on some mechanical repairs, so that the batteries can be interchanged. Relative to maintenance of these trucks, the mechanical and electrical work is handled entirely by one electrician and part time of one helper."

Mr. Billau: "The question of charging facilities is often a serious problem where you may be installing only a single truck at some terminal or outlying point, and consequently the relative investment for charging facilities becomes rather excessive. We are having very successful results in using our welding equipment for battery charging. Welding equipment of the constant potential type is working satisfactorily for battery charging purposes and the only equipment being required is one of the standard truck battery charging panels."

J. E. Gardner (C. B. & Q.): "We have found on the Burlington that the size of the battery requires a good deal of study and also the size of the truck. We have gone into the freight house handling by electric trucks quite extensively. We found for our heaviest points we had to have extra sets of batteries on the job, keep them charged up so as to use them the rest of the afternoon, because in freight house work your heaviest traffic will come in the last of the afternoon when your batteries are run down."

Mr. Bebout (C. & O.): "We have quite a number of trucks and tractors—the crane type trucks, and there is only one point on the road, our largest shop, where we have battery charging equipment for handling the truck charging. We charge at night on the electric welding system, and that generally keeps the batteries in condition to handle the truck all day. The trucks in very heavy service get boost charging. We have some batteries that have been in service about twelve years."

Mr. Marshall: "Mr. President, I would like to inquire if there is enough experience among any of the members in the use of the crane type of truck in roundhouses to show whether they are really an economic factor in the maintenance of locomotives."

Mr. Hagensick: "We purchased one of the crane type of trucks which has just been received. I would like to ask what length of boom is found most advantageous for use in the roundhouse."

Mr. Bebout: "The Chesapeake & Ohio is using a 12-ft. boom on theirs. It is a very clean type of truck, about

the handiest tool about a roundhouse, where you have no crane. I think they can be elevated to raise about 16 ft."

Mr. Hagensick: "Can you take the pump off?"

Mr. Bebout: "Yes."

The President: "The question of interchanging batteries is a subject that we have been considering. On these trucks that are mentioned in this report at this lake terminal there is a very heavy discharge, of around 200 amperes and we find that after some years of service the batteries become either sluggish or lose considerable of their capacity. The question arose as to whether it would pay us to use them in railroad cars, especially where we have double batteries. Now our discharge rate in a coach would not run any more than 45 amperes at the very outside. If you have any thoughts on the subject I would like to hear them."

Mr. Winslow: "It would appear to me that the scheme is sound because the battery in its reduced capacity condition still has efficiency as a larger type in comparison to its capacity and would be perfectly proper for a service which requires less discharge."

Mr. Diamond (Soo Line): "Mr. President, we have done that. In some cases we have taken batteries out of trucks and put them in car service. We found ourselves at one time in a position where we were short of batteries and happened to have a truck battery on hand that had been discontinued for truck service. We put it into a coach and it worked out all right and we used it for two years. After that we continued to do it with other batteries."

Heavy Electric Traction

In the absence of the chairman of the committee on Heavy Electric Traction, J. R. Sloan, the report was presented by Mr. Hagensick. After reading the report, Mr. Hagensick said: "The whole thought of the committee was simply to call these few things to your attention, and what I think we should all bear in mind is that this is purely an economic problem as we were speaking of yesterday. The engineering details are merely incidental. We all know that electrification will work. It is a matter of selecting the proper system after it has been decided that it is financially desirable. In other words, it is an economic problem and one that requires great study and a large amount of preliminary investigation so you are sure of your facts."

Mr. Dorticos (General Electric Company): "Mr. Chairman, there is a statement made in the report that no steam road has an automatic substation installed. We have a 2000-kw. substation on the New York Central that has been in operation for about a year now."

Mr. Winslow: "It might be of interest to say something further about that automatic substation the New York Central has installed as to why it was installed. The New York Central started out with a schedule of feeders of proper size and later on found between the Grand Central Station and 125th Street the voltage was too low. Then there came the question of whether they should put in a substation or additional feeders. It was decided that it was more economical to install an automatic substation, and for that reason instead of installing additional feeders to increase the voltage to a proper amount between the stations they installed this 2,000-kw. motor-generator set, with a shunt generator so arranged that it would pick up load as the voltage dropped, and it forms in itself an automatic regulating device to control the voltage."

The President; "Gentlemen, I understand the Canadian National Railway out of Toronto is proposing to electrify a portion of the road. I was wondering if Mr. Walker who is present with us today and who has made a number of investigations in connection with the work would speak to us a minute or two and tell us any of the salient points that have come up."

Mr. Walker (Canadian National Rys.): "Mr. Chairman and gentlemen: We have investigated electrification to a certain extent and we have two fairly heavy electrifications, one the Carnia Tunnel and the other the Montreal Tunnel, but I have spent a good deal of time in the investigation of the general electrification and we came to the conclusion that at present there does seem to be very much in it unless there is a special problem to tackle, a tunnel, a grade, a congestion, smoke nuisance, or something like that, and as far as main line level track is concerned we could not find very much justification, especially with the shortage of money that we have up there. On the other hand, the electrification of certain branch lines, turning them into interurban trolley line style, seems to lend itself to and give promise of certain results and we actually have under way some 50 miles, 1,500 volts which will help the heavy steam lines in handling the light freight and local passengers. When we have the plans completed we will have probably two hundred or more miles and all of this same class of light freight, not more than ten car trains. So far we cannot see very much to be gained for straight electrification of the main line."

Insulated Wires and Cables

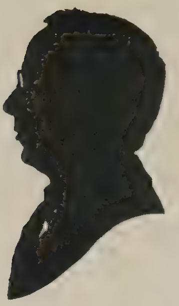
The report was presented by Mr. Billau who spoke as follows:

"I will not take the time to read this report as it is only just a brief statement of the present status of the work. It might be desirable to have a word from the secretary of the various sponsor committees as to what progress is being made and what the general prospects are. Mr. White I believe is here this morning."

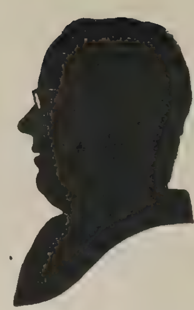
Mr. White (Okonite Co.): "Mr. President, I do not know that I can add very much to the report of the committee. As I said at the last meeting of this association, I feel that this is a pretty huge committee, this wire and cable committee. It now has about one hundred and thirty engineers working on twelve different committees. The work is all in the preliminary stages yet. It has still got to go to the sectional committee for a vote. From the sectional committee it has got to go to the sponsors, and we hope by the time it goes through all that red tape, that none of the sponsors will kick over the bucket. There are seventeen organizations interested in the work of this committee."

Illumination Report

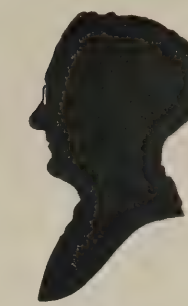
The report of the committee on illumination was also presented by Mr. Billau who said in part: "For a year or more through our committees we have been working with the lamp manufacturers with a view to developing this proposed new cab lamp, and the manufacturers have informed the committee that they are in a position today to produce that lamp on a commercial scale. The laboratory tests indicate that it is at least as good a lamp



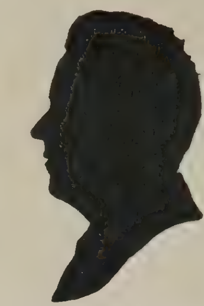
J. A. Andreucetti
Asst. Elec. Engr.
C. & N. W.
Chicago



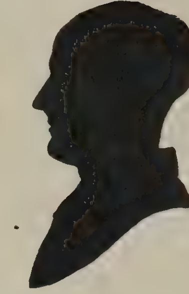
A. H. Ostberg
Mech. Engr.
C. B. & Q.
Chicago



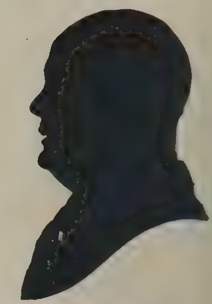
J. E. Gardner
Elec. Engr.
C. B. & Q.
Chicago



W. H. East
Asst. Elec. Engr.
C. B. & Q.
Chicago

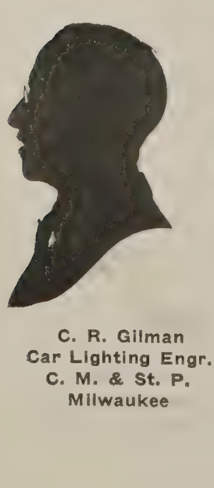


L. S. Sims
Chief Electrician
C. B. & Q.
Aurora, Ill.

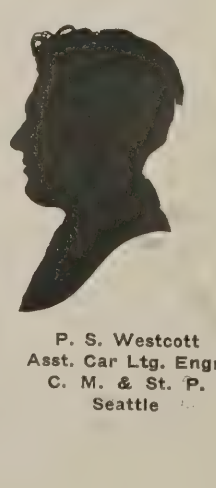


Fred McGary
Chief Electrician
C. B. & Q.
Chicago

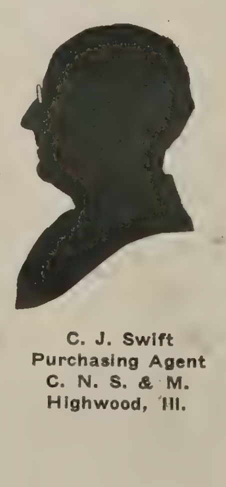
as those in use and probably better, but there is no way of finding it out except to use it. A year ago this committee asked the association if some of the railroads during the year would not try out some of these lamps on a large enough scale so that we could find out something about them, and upon taking up the matter a few weeks ago with the lamp manufacturers I find that the demand very few have gone into service. The consequence is for the lamp so far has been so small that it would appear that the matter will now have to go over for at least another year before we feel the question is in such shape that the Association can go to the lamp manufacturers with a definite recommendation that the new lamp be adopted with the idea of superseding the old lamp, and I therefore want again to urge the members of the Association as strongly as I can present it, that if we are to get the benefit of these new improvements and new developments as they come along, we can only do it through the co-operation of the railroads and particularly in the case of a lamp of this character which is in universal use throughout the country. I would like to call attention to another subject in the headlight field. There appears to be a real demand for a locomotive headlight lamp of the 250-size in a smaller bulb than the G-30. Your committee has given the matter a good deal of thought in conjunction with the lamp manufacturers, and also with the headlight committee and felt that if the 250-watt lamp were brought out in the G-25 bulb, the 100-watt lamp should be brought out in some other sized bulb so as to provide a difference in their physical dimensions. It felt that the confusion that would arise to have those two sizes of lamps in the same size bulb would be very objectionable." Mr. Billau further said: "The subject of flood lighting I feel is one of the most interesting problems that is before the Association. If it can be demonstrated that some of the advantages that have been claimed to have been secured in some yards where flood lighting or other modern systems of illumination have been installed can be duplicated elsewhere, it will be long before the use of the improved lighting is going to be very widely extended. Your committee endeavored to get some definite information which they could present at this time both from the point of view of what operating benefits are being secured and also upon the more technical phases of the question. Unfortunately it appears very difficult to obtain, and I rather doubt if there is available very much concrete data as to what extent these benefits can be evaluated in money saved in operation. I have had occasion to talk to operating officials at a number of yards where improved illumination has been installed and some of them I found had been rather bitterly opposed to the flood lighting, but who have been convinced that substantial benefits have been secured in the speeding up of the cars through the yard, a very large reduction in damage to the equipment and aiding in policing. The one thought I want to leave before the Association at this time with respect to the flood lighting question in its application to yards is that it is not as simple a problem as many of us have believed. The use of distributed flood lighting projectors through a yard in which the units are all directed with traffic, the idea being to reduce glare to a minimum, is not giving the results that you want. It reduces the glare effect effectively, but unless you go to a very high intensity of illumination, you are not illuminating your cars and yard to the extent that the car rider is able to see far enough ahead to control his movements. The layout referred to briefly in the report of placing units so that you get a silhouetting or background illumination effect is possibly a new thought to many of the railroad engineers, but from observations in such yards I think most of us will be thoroughly con-



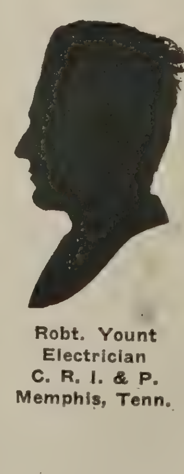
C. R. Gilman
Car Lighting Engr.
C. M. & St. P.
Milwaukee



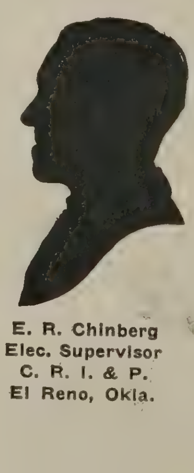
P. S. Westcott
Asst. Car Ltg. Engr.
C. M. & St. P.
Seattle



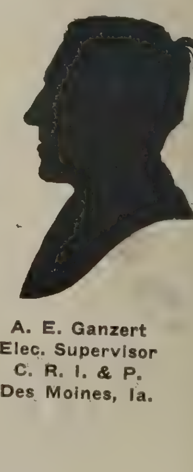
C. J. Swift
Purchasing Agent
C. N. S. & M.
Highwood, Ill.



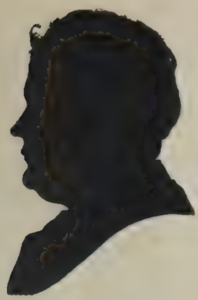
Robt. Yount
Electrician
C. R. I. & P.
Memphis, Tenn.



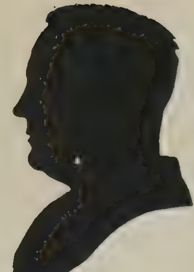
E. R. Chinberg
Elec. Supervisor
C. R. I. & P.
El Reno, Okla.



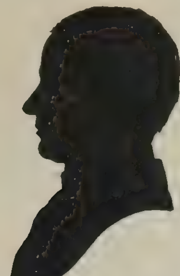
A. E. Ganzert
Elec. Supervisor
C. R. I. & P.
Des Moines, Ia.



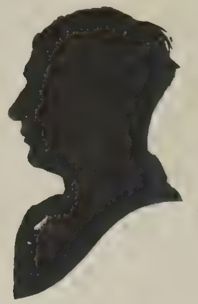
E. Wanamaker
Elec. Engr.
C. R. I. & P.
Chicago



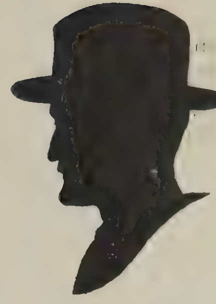
H. E. Hinds
Asst. to Supt. M. P.
Colorado & Southern
Denver



Geo. Dodds
Elec. Engr.
D. & H.
Watervliet, N. Y.



G. F. Ash
Elec. Foreman
D. & M. Ry. Co.
East Tawas, Mich.



A. M. Frazee
Elec. Engr.
D. M. & N.
Duluth

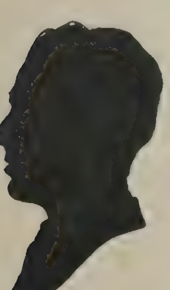
vinced that it appears to be on the right track. If you get a silhouetting effect you can get increased visibility, particularly of an object like a car, at comparatively low intensity of illumination and for comparatively long distances.

THE PRESIDENT: "As Mr. Billau has told us, flood lighting is a question about which comparatively little is known, and a very wide diversity of opinion is held on the correct standards and methods of applying the system of lighting. If you have a well lighted yard and the job has been done right, the electrical department will come in for a certain amount of praise and commendation. On the other hand, if it is not right, the electrical department will come in for considerable criticism."

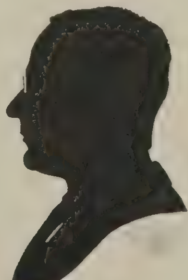
C. J. STAHL (Westinghouse Electric & Manufacturing Company): "I would like to ask if there have been any flood lighting installations or other types of yard lighting installations in which the desired silhouetting effect has been obtained. It seems to me that the application of this silhouetting effect enables us to see the outline of the back end of a string of cars rather than to locate the front end which is really the working plane."

MR. WINSLOW: "Your committee has rather leaned towards what is called the silhouetting method of illumination, and I think that is partly due to the character of the yards that have been illuminated, namely, a flat switching yard. There are two types, the flat switching yard and the hump yard or gravity yard. In illuminating a new classification yard of the hump type at Niles on the Michigan Central, flood lighting was tried, putting the main part of the illumination on the hump and a considerable amount of illumination at the other end of the yard. This produced some glare and seemed to be criticised by the hump riders, and I take a hump rider's opinion as worth considerable. The illumination was also interfered with by smoke and steam from the locomotives working at the end of the classification yard. This was then modified by placing several banks of flood lights, 1,000 watt units, along the leads, and this seemed to obviate the trouble from the locomotives, but still produced glare on account of the illumination at the end of the yard. The illumination at the far end of the yard from the hump was then changed so as to produce cross illumination, throwing the light across the yard instead of parallel to the tracks. This seemed to produce a very marked improvement and our operating force seemed to like that arrangement so well that they have, when asked about the illumination of a new yard said, 'Put in one just like that one.' Now, you might I presume get a different effect in a flat yard and my description of this one should not be taken as discouraging the silhouetting lighting effect."

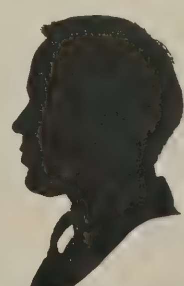
MR. MCALISTER (Electric Service Supplies Company): "Your committee report on flood lighting appears to me a very comprehensive one. I have been very much interested in hearing some of the comments that have been made and about silhouetting. We need direct light and enough of it to distinguish general contour and identify objects but rarely enough to permit details in vision. The background illumination and silhouetting is a very useful tool with most engineers who are looking after outdoor lighting. There has been a lot said at different times about glare. Glare is one of those things that a lot can be said about and without arriving at any definite conclusion. A committee of the Illuminating Engineers Society last year defined glare, as I recall it, as the sensation produced when light so invades the eye as to inhibit distinct vision. Now in a broad sense, considering the flood lighting, I think if we are going to be fair, we cannot call a flood light installation glaring if it increases your range of vision from five hundred feet perhaps under a distributed light scheme to 2,500 ft. or 3,000 ft., using



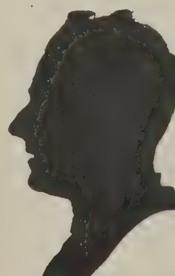
B. C. Evans
Elec. Engr.
E. P. & S. W.
El Paso, Tex.



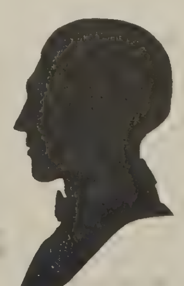
E. Marshall
Elec. Engr.
G. N. Ry.
St. Paul



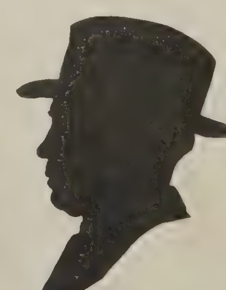
A. F. Abrahamson
Chief Electrician
Hocking Valley
Columbus, O.



J. Burchill
Car Lighting Insp.
I. C. R. R.
Waterloo, Ia.



J. B. Raymond
Electrician
I. C. R. R.
Carbondale, Ill.



R. L. Griffith
Asst. Div. Elec.
Foreman, I. C. R. R.
Memphis, Tenn.

that definition as a basis. I would like to point out that there is a balance between background illumination and direct illumination that is desirable. In flood lighting you are directing the light against working surfaces that you are most interested in as far as cars are concerned. Your rider comes down from the hump. He has his lights behind him directed on the end of the car and your man walking around the yard has the light in front of him showing up the far edge of the depressions in the ground or irregularities that he might fall over and become injured. Then, too, your car rider has the light behind him for illumination, for illuminating the car, and he has the light in front of him for showing his rail. It perhaps sounds rather far-fetched, but the rails do stand out in lighting of that sort very distinctly. It is possible in a lot of cases to distinguish a switching point for two or three hundred feet. It does not apply in every case, but the number of cases are sufficiently general to warrant a broad statement."

Mr. Minick (Pennsylvania): "Mr. Chairman, this problem, like all other railroad problems, has two sides, and I think the lack of a proper solution of the flood lighting problem has been largely due to the fact that most of those who have attempted to do anything along that line have not had a proper understanding of what is actually required. The railroad engineer knows how the yard is operated, the sales engineer who is attempting to sell him this flood light knows what the flood light will do from the standpoint of distribution of light and economy. Neither one knows what the other fellow knows, and until either one or both of them know what both sides know, you cannot expect a very satisfactory solution of this problem. I think a good deal more study can be put on this problem. While I do not want to be taken as having the attitude of severe criticism of those who are trying to market the flood lights, I do wish that something could be done to discourage the idea that the flood light is the cure for all lighting ills that cannot be solved by some other method."

Mr. Gerald (Pullman Company): "I would like to ask what the average wattage per square foot is or what they assume to start off with on such an installation.

Mr. Minick: "The best lighting that you can have in a freight yard should be that of bright moonlight, or better than bright moonlight. That runs about a quarter of a foot candle, and I should say a quarter of a foot candle would be a minimum for good lighting in a yard. Now, depending upon the contour of the yard, the location and so on, the wattage required is going to vary a great deal."

Mr. McAlister: "The matter of flood lighting applications that Mr. Minick brought out a minute ago cannot be too highly emphasized. Flood lights are not a cure all. They do fail in certain jobs. On the other hand, there is this to be said about it, that if you will take the amount of money that you will spend for a distributed yard lighting system that agrees with your yard lighting practice, and put in flood lights in most cases I think you will find that perhaps from 50 to 100 per cent increase in average illumination levels will be the result."

THURSDAY SESSION

Motor Specifications

The report of the committee on motor specifications was summarized by the chairman, E. Wanamaker. The discussion was opened by Mr. Marshall, with the following question: "I wonder how many of us are specifying motors on our requisitions as per A. R. E. E. specifications."

Mr. Sugg: "Mr. President, as soon as this specification came out, I copied it and used it as our own specification."

The President: "I would like to hear from other members of the association as to how far they are using these specifications. Mr. Wanamaker says there is not the slightest bit of use in the committee going to the time and labor of drawing up specifications if they are not used. I think that if any of us are not using those specifications, the sooner we can get into them the better. Any of the other members that are using them, or if there is any question to ask we ought to hear from you now."

Mr. Billau: "Mr. Chairman, we have been using the specifications practically in principle with some modification in wording. In view of the statement the chairman made in which he states that their railroad ordered motors as per A. R. E. E. specifications, I would like to ask whether this specification has been put in the hands of all the manufacturers of motor equipment?"

Mr. Wanamaker: "In regard to Mr. Billau's question, I will say that first, so that we would be out of the woods and save ourselves a lot of trouble, we had a lot of copies made and sent them to the various manufacturers who bid on our equipment."

E. Lunn (Pullman Company): "I would like to ask Mr. Andreucetti whether these specifications have been sent to the different motor manufacturers."

The Secretary: "They have not. Practically every motor manufacturer in the country was represented on that committee and helped in the work of formulating those specifications and practically every motor manufacturer is familiar with the specifications and knows about them."

Mr. Lunn: "It would be a little embarrassing to have you specify these specifications, that the motor shall be made in accordance with these specifications, and then have the purchasing agent come back and say the manufacturers never heard of our association and never heard of the specifications."

The Secretary: "I do not think there would be a condition of that kind. I think it is practically impossible."

Mr. Cartwright: "I would like to make a suggestion. If it would not cost too much money, I would like to suggest that when the proceedings are printed let a sufficient number of reprints of the specifications of this association be got together and published in pamphlet form so that we will all have a copy of the standard specifications of this association not only for our own information but for distribution among the manufacturers."

Mr. Billau: "Mr. Chairman, I concur in Mr. Cartwright's suggestion that the executive committee of the Association give consideration to the question of having made up in suitable form for distribution such of our specifications or other specific recommendations as outsiders may desire to use from time to time."

The President: "Gentlemen, I think Mr. Cartwright's suggestion is a good one. It appears to me that it should be acted upon. However, the matter will be referred to the next executive committee that will function for the coming year, and they will no doubt give the matter every consideration."

Electric Welding

Mr. Hagensick presented the report of the committee on electric welding and Mr. Candy of the Westinghouse Electric & Manufacturing Co. opened the discussion as follows: "Mr. Chairman, I think that the report that has just been read brings out the advantages of arc welding in its field in a very striking and justifiable manner. We have often had the question asked of us if arc welding is better than oxyacetylene or gas welding, and as it is much cheaper why isn't it pushed harder by persons interested in electric arc welding? The electric arc welding machine manufacturer cannot afford to keep representatives in the field and service installations in the same manner that the gas people do because when an arc welding machine is sold at a profit of from 15 to 25 per cent he is done on that installation. There is no more profit to be made on that. Now, take the gas welding process and we have exactly the reverse. The tools with which the welding is done a great many times could almost be furnished free of charge. A shop could almost be piped for nothing due to the fact that the gas is going to be used for those tools and it will run to several dollars an hour at a very appreciable profit."

Mr. Hagensick: "Mr. Chairman, I think one more point that might be mentioned as the reason for the predominence of gas welding in railroad shops is the fact that some of the people that furnish the gas keep men in the shops to look after their interest—welding experts who work with the local organizations continually to improve welding, but the improved welding is always with the gas process. I think the sooner the railroads get their own welding experts and tell their own forces which process to use, the sooner we will have more electric welding."

Mr. Lunn: "I think Mr. Hagensick has sounded a note that ought to be heard more widely. Everything he said is true and it is really left to the electrical engineer to try to find out what can be done with the arc welding game. From a study that I have made during the past year I have discovered quite a number of things, possibly all of them are known to others who have been longer in the business, but they were new to me, especially in connection with the welding of thin sheet metal. We have almost got it; but not quite."

Mr. Murray (Grand Trunk Western): "Mr. Chairman, I think the committee has hit upon one of the most vital questions. We have just recently appointed a man on the Grand Trunk who has complete charge of acetylene and electric welding, and it will be up to him to designate the process that is to be used. He is also to check up the cost of doing the various jobs and wherever he can recommend the use of the electric welder it is going to be installed. I would like to mention one thing that is not covered in the Committee's report, probably a little off, but we have recently put in two flue welding machines. We had the machine but had to stop right there and teach a man to operate it. In some railroads where this machine has been placed in service, removing the old flue welding outfit, setting this machine in and attempting to replace the old process, it was a very large failure and resulted in their throwing out the electric machine. In our plant they set it aside, put men on it and experimented with it and they worked it out. In about 30 days we were welding flues at an average rate of 75 per hour. The current cost is a quarter of a cent a flue. The hour rate is about two cents per kilowatt. Over the old oil welding process there is a saving of approximately four cents per flue. On a small railroad like ours we handle 50,000 flues a year so that there is a saving of over $2,000. On some of the larger railroads that saving will be multiplied a great many times."

Mr. Bebout: "In reference to cutting up cars and such work, I will say about five or six years ago we started to dismantle cars with the electric arc. We were a little afraid that the rivet cutting would spoil the sheets where the metal would fuse together. We found that that was not true, that if a man learned how to operate with the carbon arc he could cut rivet heads without burning the sheets. One man and a helper can cut off and back out about 1,400 rivets in an eight hour day. That is more than double what three men can do with the pneumatic gun."

Self-Propelled Cars

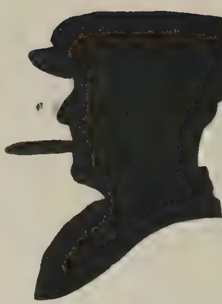
The report of the committee on self-propelled cars was presented by E. Walker, electrical engineer of the Canadian National Railways. The discussion was opened by E. Wanamaker who spoke as follows: "We have had some 12 years' experience with rail cars. The first car we had was a steam one, and the second one was steam and then the McKeane, and we are still operating McKeane cars and some General Electric and gas electric cars. The report of the committee of which Mr. Walker is chairman, I think is along the right line because he has gone into the field on a broad scale to show that if we do get together, if the various manufacturers get together and the various railroad men get together, that we can find equipments and combinations of equipments that will be suited to our needs. We had one car operate in the state of Louisiana for three years, making its round trip every day and never had any attention other than what the engineer who was operating the equipment gave it, plus the line work that was done on a siding at either end of the line, by such local help as we had which consisted of two machinists, a boiler maker and about seven laborers. Another car operated almost three years in the hill country in Arkansas in the same way, and I am not stating that to show that we had remarkable luck or success, but to show that what success we did have was due to the hearty co-operation of all concerned."

Mr. Cartwright: "I would like to ask Mr. Wanamaker what type of car of the three types was used—I don't mean the special make of car exactly, but whether it was a combination of electric and gas or straight gas for example?"

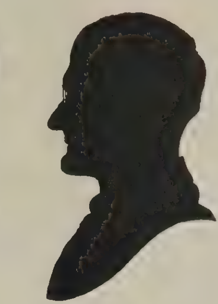
Mr. Wanamaker: "The car that was successful with us was a combination gas and electric and I want to say for the electrical equipment, especially so since this is an electrical gathering, that the electrical troubles were practically nil."

The President: "Gentlemen, there is no doubt about it that this report has brought out very thoroughly that for this particular line of activity one requires the closest co-operation between the various forces on the railroad. I notice it suggests that the individual who maintains the equipment should be of the right temperament and should be made responsible for the kind of maintenance and the care given the cars and his suggestions should receive careful attention. That on a railroad, of course, is a very difficult proposition to live up to."

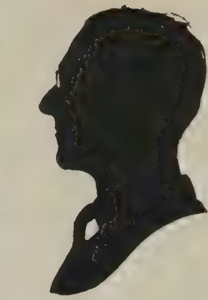
E. W. Jansen
Elec. Engr.
I. C. R. R.
Chicago



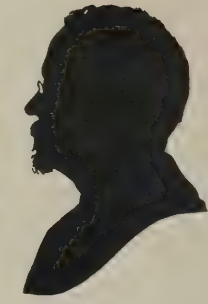
C. B. Gallagher
Elec. Dept.
I. C. R. R.
Memphis, Tenn.



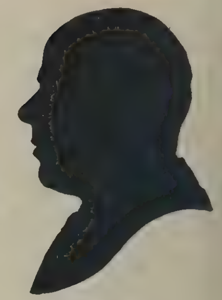
J. W. Jones
Chief Electrician
I. G. N. Ry.
Palestine, Tex.



R. E. Gallagher
Chief Electrician
L. & N.
Louisville, Ky.



D. J. Cartwright
Supv. Car Lighting
L. V. R. R.
Phillipsburg, N. J.



E. E. Segar
Elec. Foreman
M. C. R. R.
St. Thomas, Ont.

MR. WALKER: "Our cars at first were looked on with a good deal of suspicion, we find, by the regular forces. They don't like them. The success of the battery car was largely, apart from its own good qualities, due to the appointment of a young man who was thoroughly interested and energetic and was a good mixer. He lived with the cars when they started on their work. He would stay with them for many months. His knowledge of the cars, together with his qualities as a mixer, made him popular with the operating forces in the district and ended by making the cars popular. When nothing like that was done, a car put in a new district without any special man to take care of it and push it, we found that the maintenance was apt to be somewhat neglected and not carried out with the degree of enthusiasm and intelligence which is necessary."

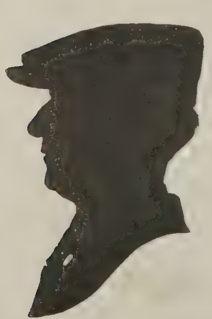
MR. BEBOUT: "About 14 years ago we tried to operate an Edison battery car. We put it on a run 12½ miles each way and we were supposed to make a schedule of 45 minutes with a layover on the Covington Road. The car had four 10 hp. Diehl series motors, 250-volt, 210 Edison A-6 batteries, located under the seats. The first trouble we found with the car was it did not trip the signals. The ballbearings were lubricated with graphite grease and we had to put collector rings on and brushes and connect it up so that it would trip. The car in itself ran very nicely and was a success so far as its running and carrying the load specified was concerned, 42 passengers, and it would carry considerably more than that, but on account of the conditions of the location, freight trains were allowed to run out ahead of it and block the line and we could not make the schedule. We cut the schedule down from 14 trips to 11 and even with 11 trips a day we could not make it without a right-of-way. They would not give us a right-of-way because the freight business was more important. Had there been a line or branch somewhere that we could have operated the car on, it no doubt would have been a success, but in that particular location it was not a success, but it was no fault of the car."

MR. MARSHALL: "Mr. President, from the discussion it would appear that the main thing in the successful operation of these cars is a little enthusiasm and considerable co-operation. A number of years ago we had two gas-electric cars. Two or three times a week we would have to displace them with a steam locomotive, and it developed that the reason that we did not have better luck with them was because we were trying to use them as locomotives. We fussed along with them a couple of years and finally got rid of them. The sole trouble of course was that we were trying to make locomotives out of them. You cannot do it. These cars, all of them, can work successfully if they are properly operated, and that means co-operation of all departments concerned."

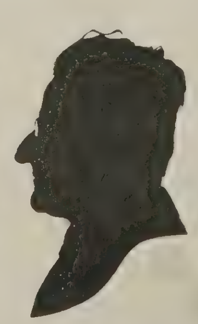
FRIDAY SESSION

Train Lighting Equipment and Practice

The report of the committee on train lighting equipment and practice was presented by Mr. Billau. George Shirk of the Great Western opened the discussion and said in part: "With reference to the subject of axle pulley bushings, I would like to describe what we are doing on the Great Western. Instead of using an axle pulley bushing we are taking a piece of flat iron of proper thickness and putting it on the axle in the shape of bands. The bands which are 2 in. wide are placed around the axle and tack welded. When the axle goes to the lathe for turning, these bands are turned to 7 9/16 in. The axle pulley bushing will be part of the axle for its entire life, and you will not require at any time the use of any shims or paper or anything else, because you have got a 1/16 in. of a squeeze which brings your pulley and your

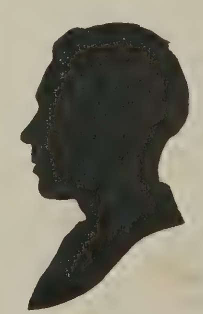


F. J. Hill
Chief Electrician
M. C. R. R.
Detroit

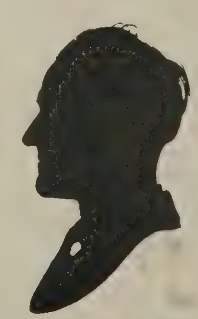


R. W. Folkinson
Chief Electrician
M. & St. L.
Minneapolis

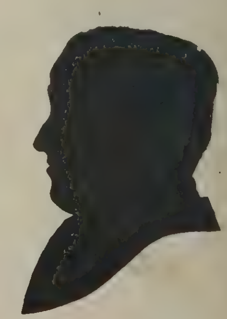
J. R. Smith
Signal Supv.
M. St. P. & S. St. M.
Minneapolis



S. D. Dimond
Chief Electrician
M. St. P. & S. St. M.
Minneapolis

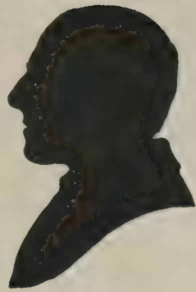


G. W. Gray
Elec. Supv.
M. P. R. R.
St. Louis

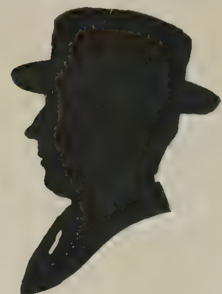


F. L. Crippen
Elec. Inspr.
N. Y. C. R. R.
New York

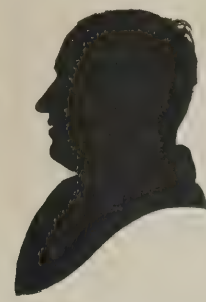
A. McGary
Ch. Elec. Car Dept.
N. Y. C. R. R.
New York



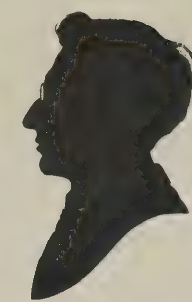
H. W. Pinkerton
Asst. Engineer
N. Y. C. R. R.
New York



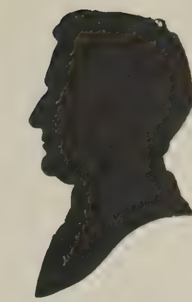
H. Bryn
Electrician
N. Y. C. R. R.
Albany



Frank Zimkowski
Gen. Car Ltg. Insp.
N. Y., N. H. & H.
New Haven



E. C. W. Geistert
Foreman Elec.
P. R. R.
Grand Rapids



C. J. Causland
Chief Elec.
Chicago Ter. Div.
P. R. R., Chicago

bushing to a metal to metal fit. The only objection is that in some of the wheel lathes the jaw will not be wide enough for this bushing to slip in, but I think most of them will."

Mr. Cartwright: "On the Lehigh Valley Railroad when we started in on car lighting, we decided to take care of the axle pulley fit by making a straight turn axle. That axle is turned throughout its whole length to a diameter of 6 3/16 in. I think I can make the statement that we have on our road at the present time certain axle bushings and pulleys that have been in service for seven or eight years without making any change."

Mr. Lunn: "It seems to me that almost everyone has a thoughtful expression on his face, and I am wondering if what Mr. Shirk has just said is not responsible for it. I know it started me thinking. I know we will do some thinking on the subject and I hope that he will not only keep us posted, but that he will keep the association posted as to his success, because if he is getting good success during the year there is no reason why we should not get some information out before another convention. I would like to hear some opinions on a subject that was mentioned in the report, and that is the practice of having ball bearings marked in such a manner as to enable a repairman to identify the bearing when it is removed in order that we may get a line on the average life of ball bearings in service."

Mr. Muelheim: "There are representatives of the ball bearing regrinding people present who might be willing to make remarks along the line Mr. Lunn

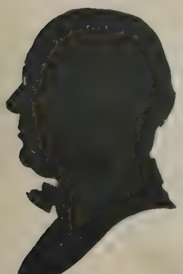
Mr. Morrison: (Ahlberg Bearing Company): "Mr. Lunn's suggestion I heartily approve and appreciate for the reason that we know all the railway companies are more or less interested in knowing definitely just what service is received from the use of ball bearings and we are making immediate arrangements to formulate a code whereby each road will understand thoroughly the service received from Ahlberg ground bearings. Any of the roads that wish to receive that code, we would be happy to give it to them."

Mr. Shirk: "On the Great Western we just use a test lamp and simply take the two little points and mark the date it was put in. It gives you a very definite mark and one that you can understand."

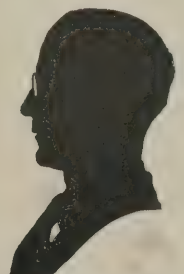
Mr. Lunn: "It is immaterial how the record is kept or what means are taken to get the information. I have talked to quite a number about it and they all feel that that is information that we ought to have. It is too valuable to be without, so let us all prepare to get it."

P. J. Callahan (Boston & Maine): "Mr. President, I would like to bring up a matter at this time in connection with train lighting which I feel has received scant attention, and that is suburban coach lighting. There are a number of installations throughout the roads and all of them differ more or less, and it seems to me that it is a subject which should receive considerable attention in order that we may come to some standard application. I had thought of the head end application as used on the Rock Island, but since then I have found out that all of the axle manufacturers or axle generator manufacturers are prepared to furnish a small axle equipment which would possibly take care of the situation. I would like to hear something concerning this headlight equipment and the axle generator."

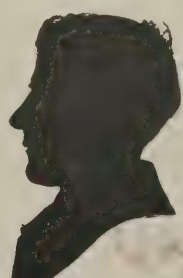
The Secretary: "Mr. Chairman, I think I know what Mr. Callahan is driving at, but I do not think we can give him very much information. I think primarily he wants to know the relative economic reasons for lighting a suburban train with head end or axle equipment. That largely depends upon conditions on a railroad. Where it may be economic and proper practice on one railroad to use axle equipment, on another railroad, due to certain conditions existing, it may be more proper and more economical to use head end equipment. For suburban



J. L. Minick
Asst. Engr.
P. R. R.
Altoona

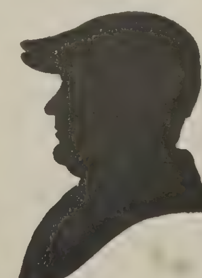


E. E. Buller
Draftsman
P. R. R.
Altoona

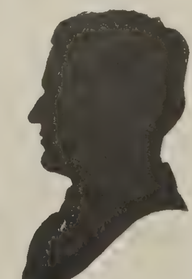


Fred Wetzel
Electrician
Pere Marquette
Grand Rapids

W. C. Groening
Air Brake Insp.
Pere Marquette
Grand Rapids



C. McDermott
Ch. Elec. Car Ltg.
Pere Marquette
Grand Rapids



Ernest Lunn
Elec. Engr.
Pullman Co.
Pullman, Ill.

service such as I might illustrate by the Northwestern, Illinois Central and Rock Island that run out of Chicago, I think that there is no question that the lighting of the train from the locomotive headlight is the most economical. I do not know the conditions on your railroad and therefore I am unable to say in my own opinion what would be the best practice for you to follow."

MR. BILLAU: "We have one special operating condition that exists on the Staten Island Lines where all of the passenger equipment is lighted with this head end system without any auxiliary lighting on the cars. It is entirely successful because the runs are short and the engines are never disconnected throughout the run.

Application of Radio to Moving Trains

The report of the radio was the longest report of the convention. Owing to the fact that this was the first time the association has had a committee on the subject, it was felt that the matter should be gone into in more detail that would be necessary in subsequent reports. The report was presented by Mr. Cartwright and by P. S. Westcott of the C. R. I. & P. In conjunction with the report a demonstration of the use of radio in connection with the printing telegraph was given. From a transmitting station, about five miles away signals were received by suitable receiving equipment and transformed into typed messages on paper tape. In discussing the demonstration, Mr. Westcott said in part: "There are a lot of these things that you might speak of as dreams of the future. This printer itself is applied in the wired telegraph today. This is just a special application. It has also been tried from the ground to an airplane, from a ship at sea to a station on land or across the land between two land stations, always with great success. Locally this same outfit has worked to Milwaukee and to Indianapolis. There is a lot to be learned, but it is brought up before the association to show the possibilities. Such an application as that, you will readily understand, carries all the responsibility of accurate operation with all the human element taken out of it. The speed device can be operated from 60 to 80 or 90 words a minute with great accuracy."

MR. LUNN: "Is this the type of machine used in overseas service between the continents and the states?"

MR. WESTCOTT: "They have an automatic type of transmitter, not this tape printer. The message is not printed in letters. It comes out as a code, and operators are located around the office, and each one getting a certain amount of tape to translate into English."

MR. LUNN: "About what speed is this running now?"

MR. WESTCOTT: "This is very slow, about 26 words. So far the tests have proven somewhere about 25 to 40 words a minute in radio application, but in wire application it is much faster and they are gradually working up their speed as they are getting into the theory of the thing as applied to radio. I was in hopes of having the signal corps loop transmitter receiver here today, but something slipped in the program and I will tell you what it is and what they are doing with it. The possibilities relating to its use between the caboose and the cab on the locomotive are very great. With this particular set we have been able to work up around 30 miles with a loop transmitter receiver. It is a small outfit, self-contained, and can be used, either for transmission or reception. That is just the possibility of what is ahead."

Locomotive Headlights

The report of the committee on Locomotive Headlights was presented by L. C. Muelheim of the Baltimore & Ohio. Mr. Murray, referring to the headlight lamps, said: "If we can get the G-25 bulb, I think the sooner we go to that the better we are off. The breaking of those lamps today is a thing that has never been overcome on the G-30 bulb, and I think the smaller bulb is going to help us."

THE PRESIDENT: "As it is perfectly evident with the two sizes of lamps, one 250 watt, and the other, 100 watt lamp in the same size bulb, considerable confusion would result in roundhouses and shops in the application of them. It is a question that warrants a little consideration and discussion."

MR. HACK (Southern Pacific): "I would like to hear from the lamp manufacturers on that. If we can place 250 watts in the G-25 bulb, we surely can reduce the size of the bulb for yard lighting. On a number of roads they use the 60 watt lamps in place of the 100 watt, even the 100 watt can be reduced down to a much smaller bulb, and as far as our road is concerned, I would not recommend a change if you are going to keep the same sized bulbs for both lamps."

MR. EARL: "Wouldn't etching the size of the lamp overcome that?"

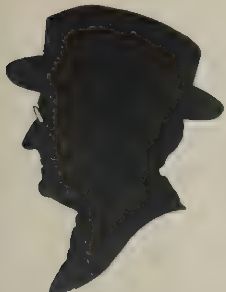
A. L. BROE (Edison Lamp Works): "I might just mention one point in connection with the marking of these lamps, that we are now etching the rating of these lamps so that there is not the danger of the label coming off that there was formerly."

MR. MINICK: "Mr. Chairman, this matter of bulb size and variety of lamps is one that I do not think we have yet secured an answer to. Nominally, the 250 watt is listed as a G-30 bulb, and the other two sizes, G-25 bulbs. There is another lamp, the 60 watt lamp, that seems to be coming in rather rapidly. From a railroad standpoint it is rather desirable that we have distinctive bulb sizes for the different wattages. While it is a very easy matter to determine the size of lamp from the label on the lamp, yet nevertheless if the package or carton in which the lamp is packed is of a different size or shape or color or something of that kind it is much easier to be handled through the storehouse."

At this point in the discussion Mr. McGinnis of the Pyle National Company and Mr. McAlister of the Electric Service Supplies Company spoke at great length on the subjects of focusing headlights and photometry of headlight lamps as a means of comparison, interpretation of the headlight law, etc.

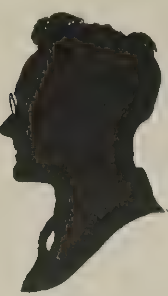
J. H. SCHROEDER (Sunbeam Electric Company): "Mr. Chairman, it seems to me that the discussion we have had shows the weaknesses of the photometric method. It is true enough that the law as it is written is very indefinite, but it just occurs to me that it might not be the best policy for this association to arrive at a method in interpreting a law and saying what will comply with the law. I do not know just what to suggest as an alternative unless we comply with the law in the same way that the government did in the states in interpreting its own law by using the same kind of a headlight, the same lamp, same voltage, all that sort of thing, as they used on the U. S. R. A. engines."

MR. MINICK: "It is going to be some years, I should



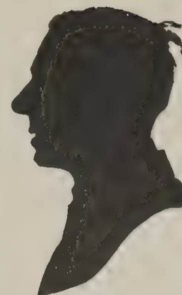
L. C. Hensel
Elec. Engr.
St. L. S. F. Ry.
Springfield, Mo.,

J. J. Hack
Car Lighting Engr.
So. Pac. Ry.
Oakland, Cal.

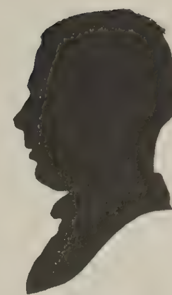


H. N. Field
Gen. Foreman Tr.
Ltg., S. Pac. Ry.
Oakland, Cal.

S. T. Sikes
Electrician
So. Pac. Ry.
Houston, Tex.



Geo. Earl
Electrician
T. & N. O. Ry.
North Bay, Ont.



J. O. Fraker
Chief Electrician
T. & P. Ry.
Marshall, Tex.

imagine, before we are able to establish definite ratios between candle power values from the headlight and pick up distances. Pick up distances vary all over the United States, with the same headlight, same photometer, same readers, everything identical. It has been possible to get in one section of the country distances up to 3,000 ft. where you could not get 500 ft. in other sections. So that the dependence upon that method of reading is rather unwise. The matter of aligning the headlight on the locomotive is a very serious matter, and it is so serious that I think some of the roads are beginning now to realize it and take some steps toward proper alignment."

Automatic Train Control

Mr. Wanamaker presented the report of the committee on train control, this subject appearing before the association for the first time as a committee report.

The President: "Gentlemen, you have heard the report presented by the committee this morning. It is a fact that generally very large subjects, very large matters have very often a small beginning. This is the beginning today as far as the Association of Railway Electrical Engineers is concerned of the question of automatic train control being brought before us. I think it is a subject that probably will be heard of in very much wider form in the future. It is a subject that should receive from this association a considerable amount of study, and this committee will undoubtedly be continued not only next year but probably for many years to come. I would suggest that all the members of the association take the maximum amount of interest in the work of the committee and assist that committee in compiling as much data and information as possible. This subject will probably break on the electrical forces or the mechanical departments pretty nearly over night. You will suddenly find a large number of the roads of the country with a lot of old locomotives equipped and the maintenance of them and the care of them will suddenly devolve on the electrical forces of the roundhouses and division and district supervising forces."

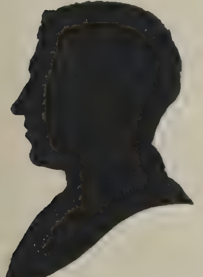
Mr. Wanamaker: "Mr. MacNab said something. There are a lot of people who are going to have this unloaded on them in short order and I am afraid they won't be very well informed. Who can maintain the stuff on the locomotives? I will tell you it is not any simple matter. The signal men have played with it from the signal end of it. They do not know anything about the air brake part of it and the minute it hits you it will hit you hard. We expect and have promised the Interstate Commerce Commission the first day of next year to have our equipment complete, so we, I guess, are the first people and so I will speak from experience. The other 49 or the rest of the 49 are going to be hit pretty hard some time between now and January 1, 1925. We tried to get this report practically to cover what we thought was a vital thing, and that is the suggestion as to how the maintenance forces could be best organized and kept together for the economic maintenance and operation of the train control."

Mr. Bebout: "I have a report here on six months operation, the last six months of it, on train control equipment on the Chesapeake & Ohio. We have been running on the Richmond division between Gordonsville and Charlottesville about six or seven years in successful operation. You might call it successful because the number of failures are few in proportion to the operations."

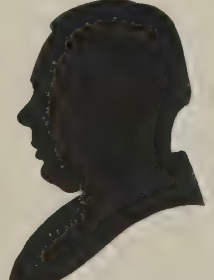
Mr. Cartwright: "I would like to ask if those operations were all confined to the train itself."

Mr. Bebout: "The signal troubles were included in the electrical troubles."

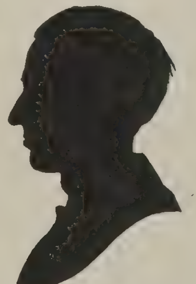
Mr. McGinnis: "Is this train control and train stop combined, or train stop only?"



E. H. Hagensick
Elec. Engr.
Union Pacific
Omaha

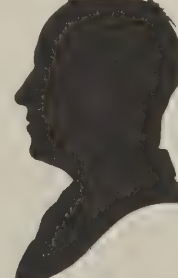


L. E. Edwards
Asst. Elec. Engr.
A. T. & S. F. Ry.
Topeka

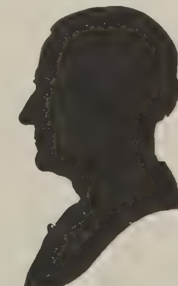


H. A. French
Elec. Storkeeper
A. T. & S. F. Ry.
Topeka

P. B. Streeper
Gen. Elec. Foreman
Wabash R. R.
St. Louis



T. F. Foltz
Elec. Engr.
Washington Term.
Washington, D. C.



C. B. Cramer
Master Mechanic
Washington Term.
Washington, D. C.

MR. BEBOUT: "It is train control and stop."

MR. MCGINNIS: "Do you call any failure to control the train a failure?"

MR. BEBOUT: "What we call a failure is when the train stops without proper signals, that is, if everything is clear and he gets stop signals that he should not get. It always stops, never fails to stop, but the trouble is it sometimes stops too often, and that is what we call a failure."

MR. WANAMAKER: "Mr. Bebout, may I ask you how you stopped the frost trouble?"

MR. BEBOUT: "By a heavier spring in the shoe. We had a one-quarter inch steel spring in the shoe to start with and when we run into frost trouble we went to a five-sixteenths. We first put in a three-eighths, but that was going too far. We dropped back to five-sixteenths, and that is around five or six hundred pounds pressure. I might say on the a. c. system it is a little different from the direct current. The direct current system has shoes on both sides. They are in operation all the time. That is, one side takes in the signal indications and the other side gets the stops. It is operated from ramp rails on both sides of the track in a signal system. The a. c. instead of using the two ramp rails has a divided ramp. You get your signal on the first section of the ramp and your stop on the second. You also get your speed control that way."

THE PRESIDENT: "Gentlemen, this concludes the fourteenth annual convention of the association."

Election of Officers

The following officers for the Association of Railway Electrical Engineers were elected to serve for the ensuing year: Ernest Lunn, Pullman Company, president; F. J. Hill, Michigan Central Railroad, first vice-president; E. Wanamaker, Chicago, Rock Island & Pacific Railroad, second vice-president. George Shirk, Chicago & Great Western Railway, and J. L. Minick of the Pennsylvania System were elected as members of the executive committee.

Standardization of Railway Car-Type Resistors*

STANDARDIZATION of grid resistors is a practical method for reducing operating expenses by reducing the number of spare parts necessary to adequately maintain equipment. A system using only one type and size of equipment would require only one layout of resistors, and consequently a relatively small number of spares. However, large systems using many different types of equipment experience considerable trouble and expense in maintaining resistors. How to reduce the cost of maintaining grid resistors and their parts on such systems has been the problem of many operators.

For railway companies using many different types of equipment the latest and, under most conditions, the best method of reducing resistor expense is the adoption of a system of resistor standardization.

The ideal resistor equipment would be one in which grids of only one size are mounted in one frame, varying the number of these complete resistors to suit the motor and control equipment. However, where many different types of motor and control equipments are used on various types of cars it is usually impossible to carry the standardization this far. This is due to the capacity requirements and the various number of controller steps common to any one property. It is usually possible to confine a complete standardization to not more than two different sizes of grids. When more than one size of grid is required for a complete standardization the design is laid out so as to use one size of grid in a frame wherever possible. The term "size of grid" as used herein refers to the current capacity and resistance value. One method of standardization that usually gives entire satisfaction is to have a group of standard resistors all of the same frame length, and from this group certain frames can be connected in an assembly that will give the required acceleration and current carrying capacity to any particular car equipment. Other assemblies can be had by using other combinations of frames so that from this group of standard resistors it is possible to get an assembly suitable for each type of motor and control equipment used.

In operation a number is usually assigned to each standard resistor frame. Thus, in case of failure or breaking of grids, it is only necessary to remove the defective frame and replace it by another of the same number, making the proper connections of resistor leads as shown on the car wiring diagrams. The car is then again ready for service. The damaged frame can be repaired later in the shop. Among the advantages resulting from the use of this method are:

1. The variety of types and sizes of grids that must be carried in stock is decreased.

Therefore:

A. Less space is required in the stockroom.

B. A more orderly arrangement of parts can be made in the stockroom, especially if assembled resistor frames of a common length are kept in stock.

C. Investment for spare parts for stock is reduced.

2. Repairs can be made more quickly. The cars are therefore in service a higher percentage of the time.

3. Resistor grids used for standardization purposes are stock which enables shorter deliveries from the manufacturer.

Beginning with the purchase of a certain lot of cars, the resistor frames for these cars and cars later purchased can usually be standardized. To extend this standardization to older cars will, in some cases, require relocating other apparatus, and the question to be determined, therefore, before standardizing on the new cars, is that of selecting the standard frame length that can be applied to all cars, old and new, with the least expense in changing other apparatus under the car. Then the problem is to reduce the number of different grid resistors required to make up the frame to not more than three, and, if possible, two.

The standard resistor frame would provide for one standard tie rod with insulation, one type of terminals, etc., that are a part of the resistor. Further economies can be obtained by standardizing the insulated bolts, the hangers on the car and the method of mounting the resistors.

To make a resistor standardization, a thorough study of service conditions must be made, and complete information is required on the various weights of cars, types of motors, types of control, diameters of wheels, gear ratios, etc.

*From a leaflet issued by the Westinghouse Electric & Manufacturing Company.

Interesting Exhibit Studied at Convention

Rousing Interest of Railroad Men In Apparatus Displayed Keeps Manufacturer Busy

INCREASING interest is being shown by the railroad men in the exhibits offered by the Railway Electrical Supply Manufacturers' Association members in conjunction with the annual convention of the Association of Railway Electrical Engineers. All of the available space was taken and indications point to the need for larger quarters for next year's exhibits. A few new manufacturers exhibiting for the first time showed some very novel apparatus and many of the other companies had numerous new devices of interest. The manufacturers' representatives commented on the fact that the remarks and suggestions of the railroad men as offered at the exhibit booths were the greatest helps in developing their equipment to meet the railroad requirement.

Election of Officers

At the meeting of the Railway Electrical Supply Manufacturers' Association on Thursday morning, November 8, the following officers were elected for the coming year:

President, R. L. McLellan, Westinghouse Electric & Manufacturing Company, New York; senior vice-president, George H. Scott, Safety Car Heating & Lighting Company, Chicago; junior vice-president, E. A. Lundy, *Railway Electrical Engineer,* Cleveland; secretary, J. Scribner, General Electric Company, Chicago; treasurer, Edward Wray, Railway Purchases & Stores, Chicago. Executive Committee: J. W. Porter, Electric Service Supplies Company, Chicago; Otis B. Duncan, Western Electric Company, Chicago; R. N. Baker, Central Electric Company, Chicago; R. I. Baird, Electric Storage Battery Company, Chicago; W. F. Bauer, Edison Storage Battery Company, Chicago; John McC. Price, Industrial Controller Company, Milwaukee, Wis.; W. A. Ross, Oliver Electric & Manufacturing Company, St. Louis, Mo.; W. H. Fenley, Kerite Insulated Wire & Cable Company, Chicago; Charles Dubsky, Crouse-Hinds Co., Chicago.

Exhibitors, Their Products and Representatives

The exhibits well represented all the various equipment which the railway electrical men have in charge, and in order to give the reader an idea of the exhibits the following is an alphabetical list of the manufacturers, together with a brief list of the product on display and the names of the representatives present at the convention.

Albert and J. M. Anderson Manufacturing Company, Boston, Mass.—Complete line of charging plugs and receptacles for yard charging plants and car equipment; line of plugs and receptacles for arc-welding distribution both for d.c. and a.c., including double, triple and four pole types; line of plugs and receptacles for headlighting. Represented by B. G. Durham, Chicago.

The Ahlberg Bearing Company, Chicago—This exhibit consisted of a complete line of ball-bearings for headlight generators, axle light generators, etc. This company also exhibited numerous oversize bearings as used in reground races. This company has recently secured the agency for the Hollman bearing made in Wetzler, Germany. Represented by D. A. Campbell, B. B. Clark, H. E. Dunning, K. R. Morrison, W. C. Bender, R. E. Bender, C. W. Pearsall, W. C. Fries, Chicago.

Appleton Electric Company, Chicago—Mogul type "Reelites" equipment for reeling up extension cords. These devices are now made for any length of ordinary cords, the largest in exhibit being for 75 feet of No. 12 three wire cable. Represented by A. S. Merrill, D. G. Welling, E. A. Hakanson.

Baker, R. & L. Company—This company exhibited an electric storage battery tractor for handling trailer trucks in shops, freight houses or store rooms. Represented by W. S. Hebard, G. W. Barnes, V. A. Shouldis, Chicago, and Frank Phelps, Cleveland.

Benjamin Electric Manufacturing Company, Chicago—This company exhibited various switches and sockets and electrical fixtures, specializing on new "glass-steel" reflectors and outdoor lighting equipment with a cast iron threaded hood for railroad shops and roundhouses. A new fibre hand portable lamp being so insulated as to be free from grounds was another feature of this exhibit. Represented by Thomas W. Carlson, Wallace J. Goodrich, Chicago, and Raymond M. Prior, Cleveland.

Bryant Electric Company, Bridgeport, Conn.—In addition to the regular line of plugs, receptacles, etc., this company exhibited a new line of plug fuses with the hexagonal opening in the cup for all fuses under 15 amp., and for those above this rating the round opening is used. "Undark" luminous switch buttons and socket chains of radium luminous material were also shown. Represented by J. Ward Thomas, Clyde W. Foster, W. O. Dahlstrom, W. A. Stacey, Chicago, and George H. Williams, New York.

Buda Company, Harvey, Ill.—A new type of ball-bearing unit housing for the steam end of their headlight turbo-generator was one of the features of this exhibit. Represented by H. P. Bayley and Mark A. Ross, Chicago.

Central Electric Company, Chicago—"Maxolite" reflectors for shop lighting, receptacles and plugs, car fans, Okonite wires and cables, Manson Tape, "Attalite" fixtures for general lighting and Gibbs train connectors. Represented by A. L. McNeil, Ray N. Baker, J. M. Lorenz, E. H. McNeil, Chicago; J. D. Underhill, F. H. White, W. J. Hackett, New York, and L. R. Mann, St. Louis.

Chicago Fuse Manufacturing Company, Chicago.—An extensive display of enclosed fuses, all types and sizes, refillable and non-refillable; outlet boxes and switch receptacles. Represented by H. P. Collins and C. W. Beach, Chicago.

Crouse-Hinds Company, Syracuse, N. Y.—Condulets, safety switches, carlighting panels, flood lighting units formed the principal part of this exhibit. A heavy duty plug and receptacle and also an interlock plug and switch made in sizes from 30 to 200 amp. at 250 to 600 volts formed the principal new items of interest. Represented by A. F. Hills, C. H. Bissel, E. G. Smith, Syracuse, N. Y.; Charles Dubsky, N. E. Bigley, W. L. Johnson, Chicago; A. B. McChesney, Detroit; A. E.

Vieau, Minneapolis, and J. B. Wilmott, A. B. Spicer, St. Louis.

Cutter Electric & Manufacturing Company, Philadelphia—This company exhibited a full line of "U-re-lite" circuit breakers and I-T-E circuit controllers, for railroad shops circuits. Represented by E. Swift Newton, Philadelphia; O. M. Burcaw, I. Allen, Chicago; T. Beasley, St. Louis.

Edison Storage Battery Company, Orange, N. J.—The exhibit of this company included a nickel-alkaline Edison storage battery which has been in car lighting service for 12 years. Represented by D. C. Wilson, W. F. Bauer, A. M. Anderson, O. M. Neidermeyer, Chicago; R. C. Haley, St. Louis; J. A. Cassidy, Atlanta.

Electric Controller & Manufacturing Company, Cleveland—The exhibit of this company included induction motors, starting switches, manual and automatic compensators. Representatives, J. P. Moore, F. R. Fishback, Cleveland; R. E. Bock, A. J. Walz, E. C. Ryan, Chicago.

Electric Service Supplies Company, Philadelphia—This company exhibited a full line of locomotive headlights and turbo-generators. An interesting model showing the lubricating system of the Keystone turbo-generator was one exhibit. A new line of dust-proof enclosed reflectors for roundhouse and shop lighting was a feature of the exhibit. Represented by J. W. Porter, H. J. Graham, L. A. Darling, B. D. Berger, T. M. Childs, F. G. MacAllister, Chicago.

Electric Storage Battery Company, Philadelphia—A complete car lighting equipment including a motor driven axle equipment controller and battery. The new "Gummite" battery container, performing the function of both a tank and crate, was one of the new features. Represented by J. L. Woodbridge, William H. Palmer, Jr., Thomas L. Mount, Philadelphia; G. H. Atkin, T. Milton, R. I. Baird, H. E. Kirby, O. R. Shortall, H. M. Beck, Chicago; H. B. Hamilton, Cincinnati; J. D. Fischer, Minneapolis; E. L. Lord, San Francisco; H. W. Beedle, Boston; R. M. Pfluke, Rochester; A. E. Wilkes, Toronto; D. T. Swain, Omaha; T. P. O'Malley, St. Louis; W. H. Payne, George V. Cripps, Cleveland.

Fairbanks, Morse & Company, Chicago—In addition to a sectional demonstration of a ball-bearing motor this company exhibited a small motor generator set for charging batteries. Represented by B. S. Spaulding, E. C. Golloday, C. H. Wilson, F. J. Lee, F. M. Condit, P. H. Gilleland, G. W. Lewis, M. O. Southwork, Chicago, and G. Howard, St. Paul.

General Electric Company, Schenectady, N. Y.—This company exhibited battery charging equipment, locomotive headlights, motor control devices, and the feature of the exhibit was a large cast aluminum floodlight unit with a front glass cover of 19½ in. diameter. Represented by W. M. B. Brady, C. Dorticos, W. G. Ferguson, Chicago; R. L. Hughes, St. Louis; John Roberts, C. C. Bailey, Schenectady; W. K. Hadley, New York; F. P. Jones, Philadelphia; A. L. Broe, Harrison, N. J.

Gould Storage Battery Company-Gould Coupler Company, New York—Car lighting and headlighting equipment was exhibited by this company, features being a geared axle generator drive and a high frequency a.c. turbo-generator. Represented by George R. Berger, Chicago; W. F. Bouche, M. R. Shedd, De Pew, N. Y., and P. H. Simpson, New York.

Howell Electric Motors Company, Howell, Mich.—Exhibit included "Red Band" motors of both the vertical and horizontal shaft types. Ball-bearing and recentering bearings were a feature of the exhibit. Represented by C. F. Norton, Howell, Mich., and O. A. Reed, Chicago.

Industrial Controller Company, Milwaukee, Wis.—Exhibited a line of manual and automatic starters and compensators. A new disconnector switch with automatic and hand compensators with a test jack to get readings on motors was an interesting part of the exhibit. Represented by John McC. Price and E. J. Rooker, Chicago.

Ivanhoe Regent Works of General Electric Company, Cleveland—Exhibited a complete line of metal and glass reflectors for railroad shop, yard and platform lighting. Represented by G. W. Beals, W. F. Minor, L. C. Doane, John Cornish, Cleveland.

The Kerite Insulated Wire & Cable Company, Inc., New York—Exhibited samples of power cable, charging cable, headlight wire with special braid finish, building and car wire, plain battery connector cable and ignition wire. Represented by Col. Azel Ames and P. W. Miller, New York; E. L. Adams, J. A. Hamilton, W. H. Fenley, C. A. Reeb and C. E. Hieber of Chicago.

Krebs Manufacturing Company, Chicago—A universal axle pulley for belt connected body hung generators was exhibited by this company. This pulley is built around a universal joint that fits on the axle so that when a car rounds a curve the pulley swings and thus prevents the belt climbing off. Represented by Guilford S. Wood, E. G. Smith, F. W. Wocher, George E. Pratt, C. E. Krebs, Chicago.

Loeffelholz Company, Milwaukee, Wis.—The exhibit of this company included a full line of "Gibbs" train line connectors, receptacles, hooks and hangers. The adapter sleeve was a feature of the exhibit. Represented by George B. Miller, Milwaukee.

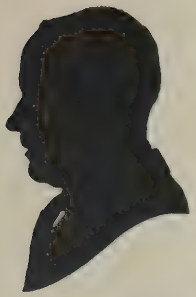
Mutual Electric & Machine Company, Detroit—Exhibited a line of "Bull-dog" safety type enclosed switches. Represented by E. A. Pritz, G. R. Watson and L. H. Frank.

National Lamp Works of General Electric Company, Cleveland—This company exhibited a full line of mazda lamps for car lighting, headlights and general illumination. A revolving bumper test showing the rough use a lamp will stand was in constant operation. Superiority of a gas filled lamp was also demonstrated. Represented by C. R. Stover, H. H. Helmbright, W. M. Langstaff, Cleveland.

Oliver Electric & Manufacturing Company, St. Louis—Exhibited locomotive and passenger car wiring fixtures and safety portable hand lamps. A new switch and cut out combined in one cast case and the screw cover junction boxes were features of the exhibit. Represented by J. A. Amos, William M. Graves, St. Louis; W. A. Ross, Chicago, and G. V. Wright, New York.

Pyle-National Company, Chicago—Turbo-generators for head lighting and train lighting, flood lighting units and marker lights. Represented by J. Will Johnson, W. Miller, J. L. Reese, R. L. Kilker, C. P. McGinnis, A. R. Allen, G. E. Haas, Carl S. Geis, Chicago.

Safety Car Heating & Lighting Company, New York—Exhibit included car lighting generators, regulators,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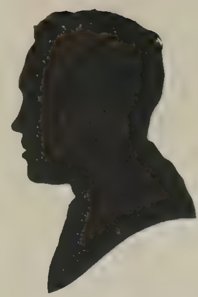
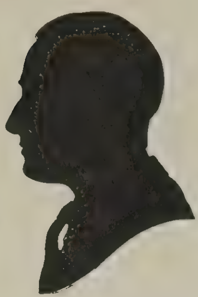
Adams Westlake Co.
Chicago


R. E. Bender
Ahlberg Bearing Co.
Chicago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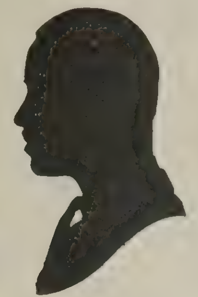
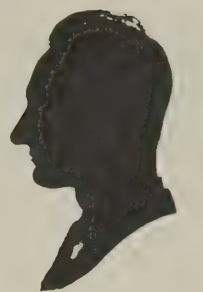
Chicago


C. W. Pearsall
Ahlberg Bearing Co.
Chicago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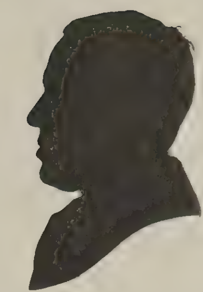
A. & J. M. Anderson
Mfg. Co., Chicago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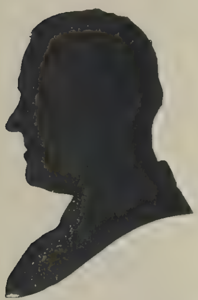
Bates Expanded Steel
Truss Co., Chicago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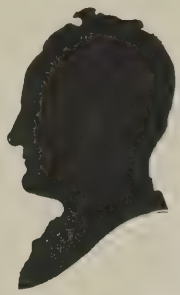
Co., Chicago


T. W. Carlson
Benjamin Elec. Mfg.
Co., Chicago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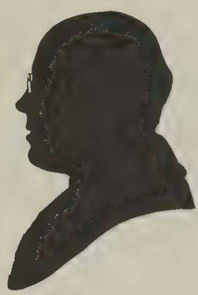
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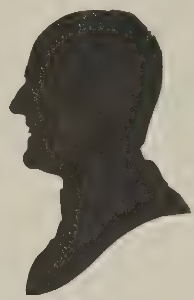
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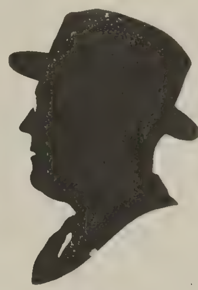
Co., Baltimore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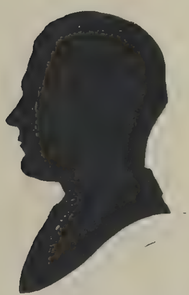
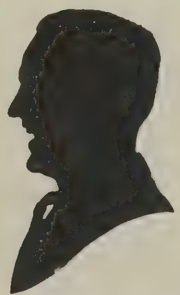
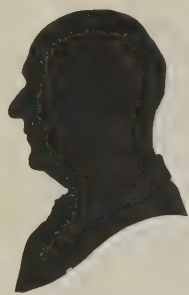
Bridgeport Brass Co.
New York


C. W. Foster
Bryant Electric Co.
Chicago


E. H. McNeill
Central Electric Co.
Chicago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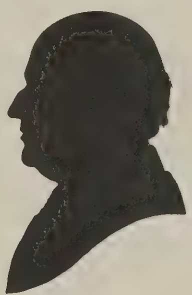
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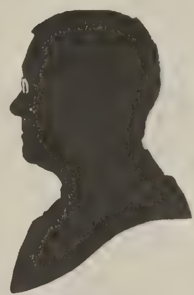
Central Electric Co.
Chicago


A. L. McNeill
Central Electric Co.
Chicago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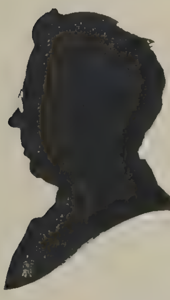
Chicago Fuse Mfg. Co.
Chicago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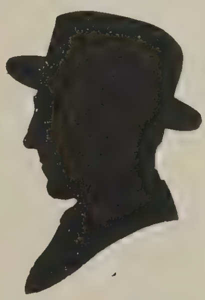
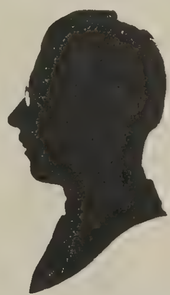
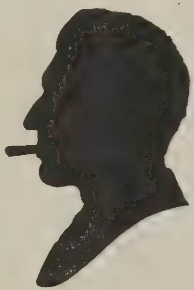
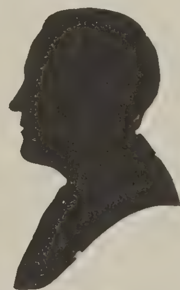
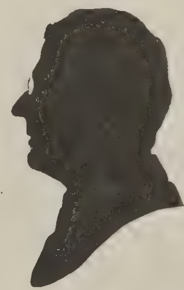
Chicago

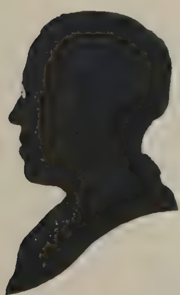

C. Dubsky
Crouse Hinds Co.
Chicago


J. S. Allen
Cutter Elec. & Mfg.
Co., Chicago


O. M. Bereau
Cutter Elec. & Mfg.
Co., Chicago


D. C. Wilson
Edison Storage Batt.
Co., Chicago


W. F. Bauer
Edison Storage Batt.
Co., Chicago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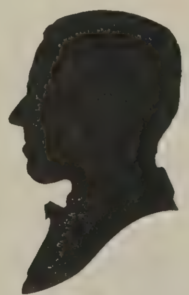
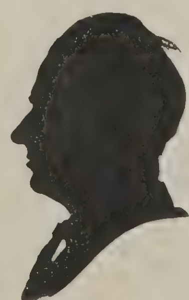
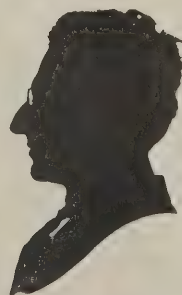
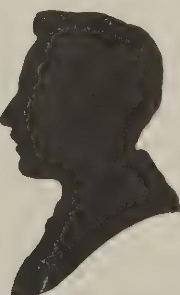
Edison Storage Batt.
Co., Atlanta


A. L. Broe
Edison Lamp Works
Harrison


J. P. Moore
Elec. Controller &
Mfg. Co., Cleveland


A. J. Walz
Elec. Controller &
Mfg. Co., Chicago


L. A. Dorling
Elec. Serv. Supplies
Co., Philadelphia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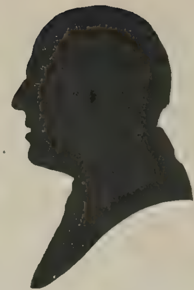
Elec. Serv. Supplies
Co., Philadelphia


T. M. Childs
Elec. Serv. Supplies
Co., Chicago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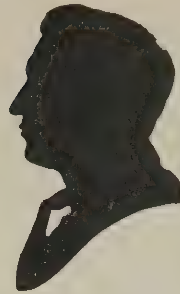
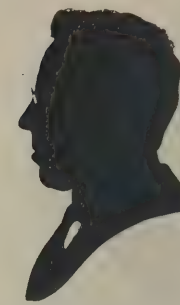
Elec. Serv. Supplies
Co., Philadelphia

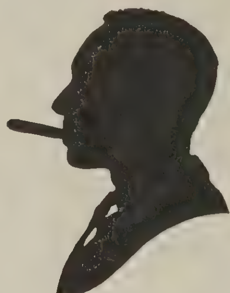

B. D. Barger
Elec. Serv. Supplies
Co., Chicago


T. L. Mount
Electric Storage Batt.
Co., Philadelphia

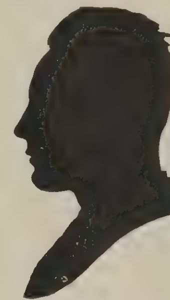

G. V. Cripps
Electric Storage Batt.
Co., Cleveland

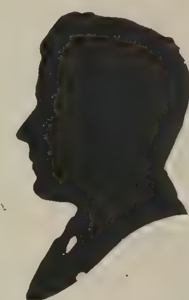

E. L. Lord
Electric Storage Batt.
Co., San Francisco


D. T. Swaim
Electric Storage Batt.
Co., Omaha


R. V. Baird
Electric Storage Batt.
Co., Chicago


G. H. Atkin
Electric Storage Batt.
Co., Chicago


J. D. Fischer
Electric Storage Batt.
Co., Minneapolis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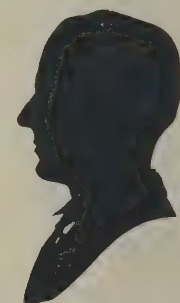
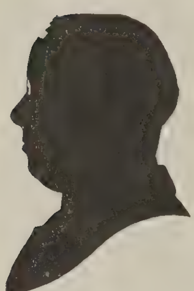
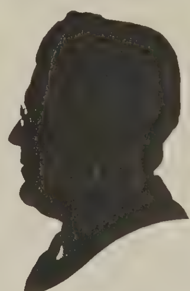
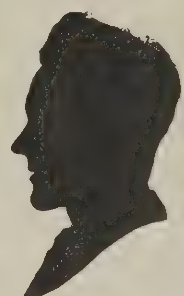
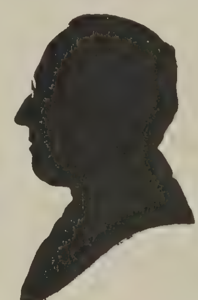
Electric Storage Batt.
Co., Cincinnati

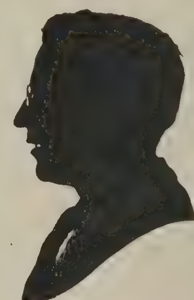

R. M. Kinney
Fairbanks Morse &
Co., Chicago

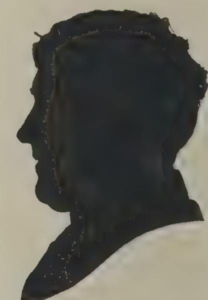

G. Howard
Fairbanks Morse &
Co., Chicago

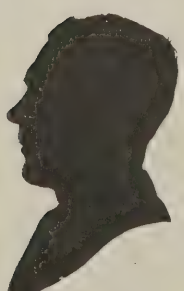

C. H. Wilson
Fairbanks Morse &
Co., Chicago

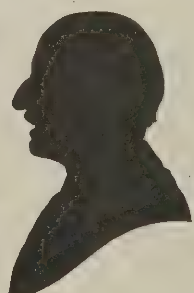

W. M. B. Brady
General Electric Co.
Chicago

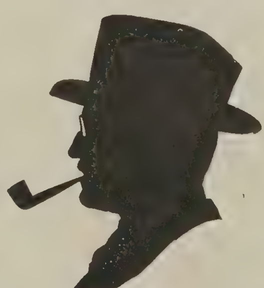

John Roberts
General Electric Co.
Schenectady

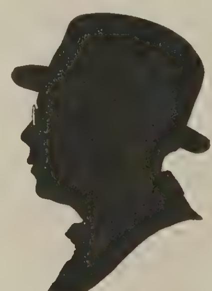

R. I. Parker
General Electric Co.
Chicago

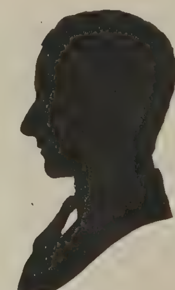

C. Dorticos
General Electric Co.
Chicago

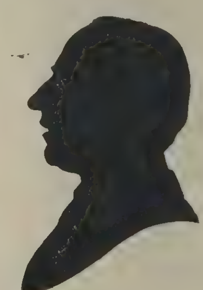

F. F. Sengstock
General Electric Co.
Chicago

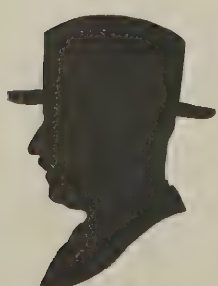

J. Scribner
General Electric Co.
Chicago

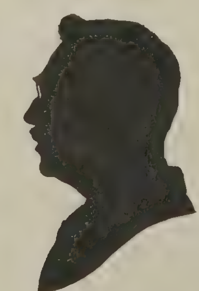

F. P. Jones, Jr.
General Electric Co.
Philadelphia


P. S. Bailey
General Electric Co.
Lynn, Mass.

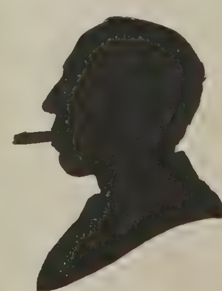

C. C. Bailey
General Electric Co.
Schenectady

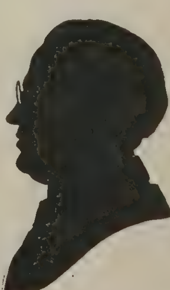

G. R. Berger
Gould Coupler Co.
Chicago

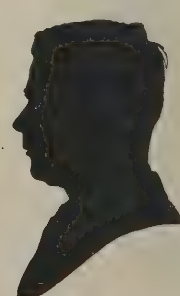

P. H. Simpson
Gould Coupler Co.
New York

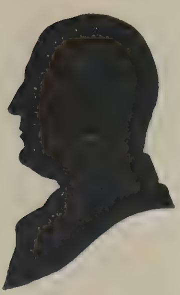

M. R. Shedd
Gould Coupler Co.
Depew, N. Y.


W. F. Bouche
Gould Coupler Co.
Depew, N. Y.

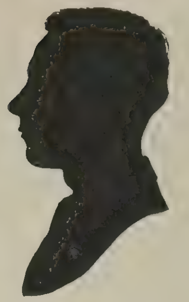

J. M. Johnson
Howell Elec. Motors
Co., Chicago

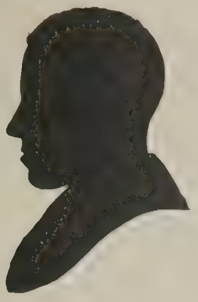

O. A. Reed
Howell Elec. Motors
Co., Chicago

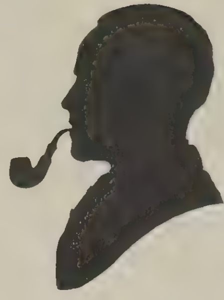

C. F. Norton
Howell Elec. Motors
Co., Howell, Mich.

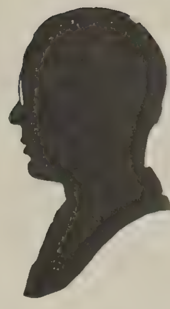

D. S. Wilkus
Howell Elec. Motors Co., Chicago

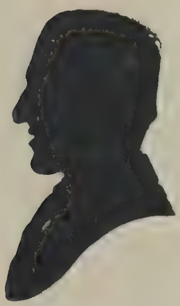

J. McC. Price
Indus. Controller Co.
Chicago

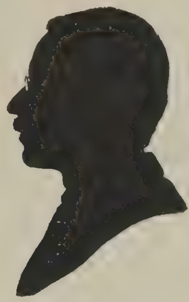

E. J. Rooker
Indus. Controller Co.
Chicago

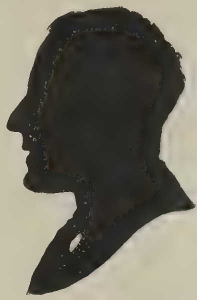

J. M. Hickerson
Ivanhoe-Regent
Cleveland

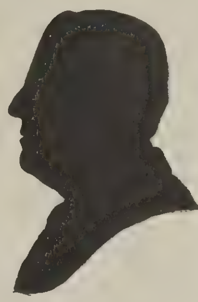

G. W. Beals
Ivanhoe-Regent
Cleveland

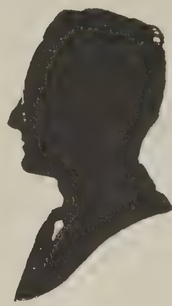

L. C. Doane
Ivanhoe-Regent
Cleveland

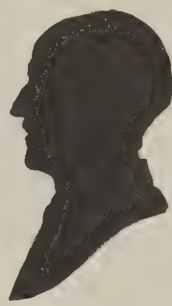

John Cornish
Ivanhoe-Regent
Cleveland


E. L. Adams
The Kerite Co.
Chicago

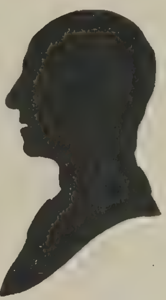

J. A. Hamilton
The Kerite Co.
Chicago


P. W. Miller
The Kerite Co.
New York

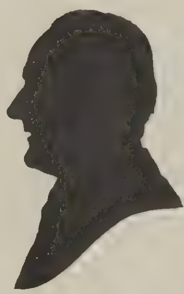

C. A. Reeb
The Kerite Co.
Chicago

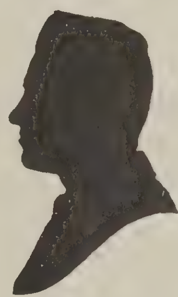

Azel Ames
The Kerite Co.
New York

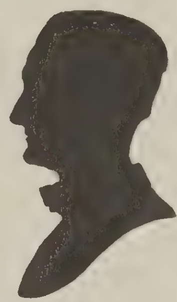

W. H. Fenley
The Kerite Co.
Chicago

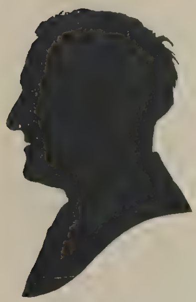

E. G. Smith
Krebs Mfg. Co.
Chicago

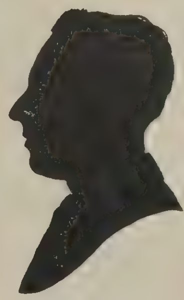

G. E. Pratt
Guilford S. Wood Co.
Chicago


C. E. Krebs
Krebs Mfg. Co.
Chicago

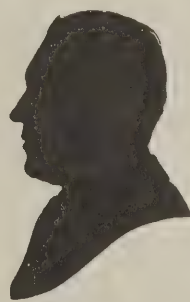

O. H. Fuese
Lincoln Electric Co.
Chicago


Wm. Dewyer
Lincoln Electric Co.
Chicago

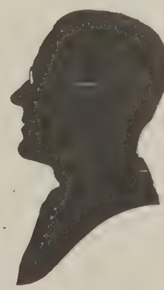

G. B. Miller
Loeffelholz Co.
Milwaukee

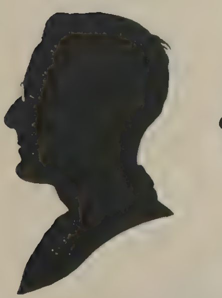

P. G. Lewis
Loeffelholz Co.
Milwaukee

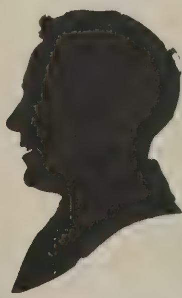

L. J. Kline
Mercury Mfg. Co.
Chicago

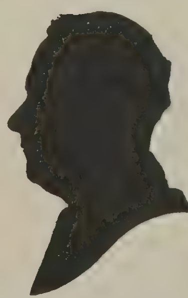

L. F. Meissuer, Jr.
Mercury Mfg. Co.
Chicago

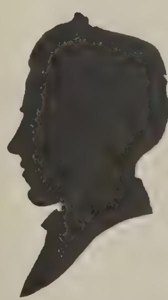

D. H. Green
National Carbon Co.
Chicago

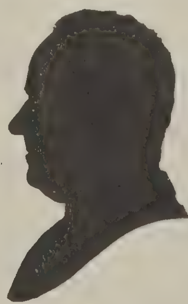

A. E. Pratt
National Carbon Co.
Cleveland

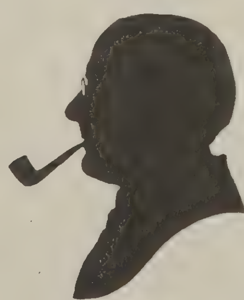

H. H. Helmbright
National Lamp Works
Cleveland

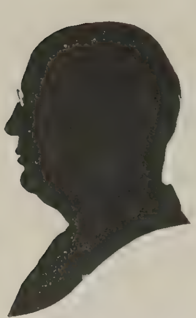

L. C. Kent
National Lamp Works
Cleveland


C. R. Stover
National Lamp Works
Cleveland

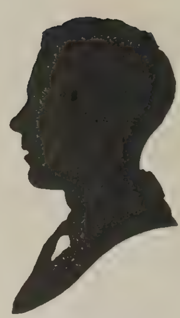

Wm. Langstaff
National Lamp Works
Cleveland


J. W. Hackett
The Okonite Co.
New York

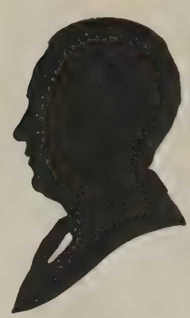

F. J. White
The Okonite Co.
New York



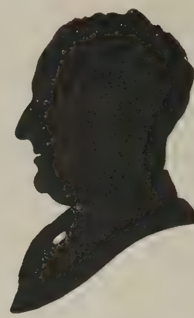
J. F. Underhill
The Okonite Co.
New York



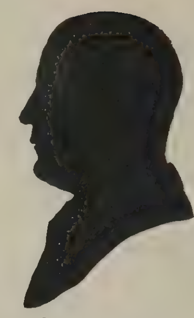
G. V. Wright
Oliver Elec. & Mfg.
Co., New York



W. M. Graves, Jr.
Oliver Elec. & Mfg.
Co., St. Louis

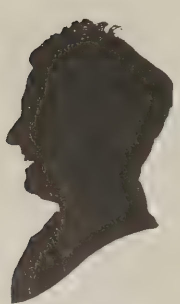


Wm. A. Ross
Oliver Elec. & Mfg.
Co., Chicago

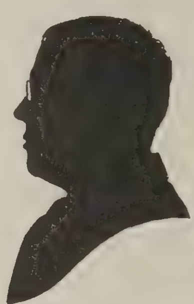


J. A. Amos
Oliver Elec. & Mfg.
Co., St. Louis

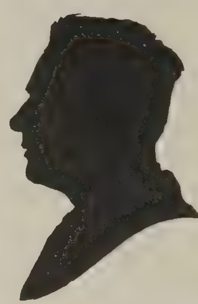
J. P. Murphy, Jr.
Purchases and Stores
Chicago



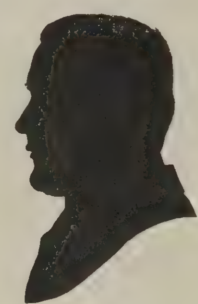
Ed Wray
Purchases and Stores
Chicago



H. B. Kirkland
Purchases and Stores
Chicago



A. R. Allen
Pyle National Co.
Kansas City



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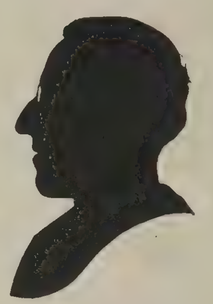
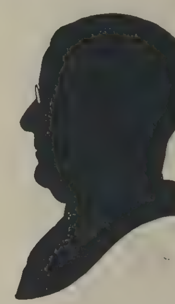
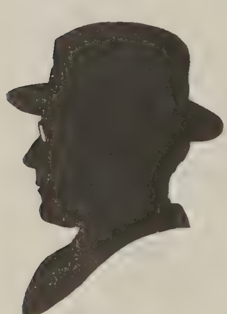
R. C. S. Equipment
Corp., New York



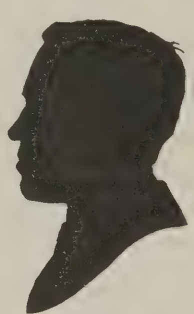
F. M. Rosenzweig
Regan Saf. Devices Co.
Chicago



J. Beaumont
Regan Saf. Devices Co.
Chicago



F. J. Lepreau
Regan Saf. Devices Co.
New York



J. L. Marsh
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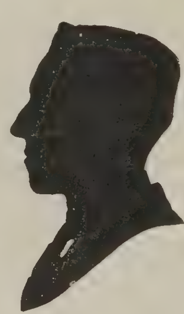
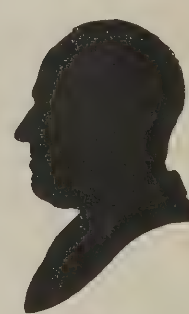
Ltg. Co., Philadelphia



H. K. Williams
Safety Car Heat &
Ltg. Co., New York



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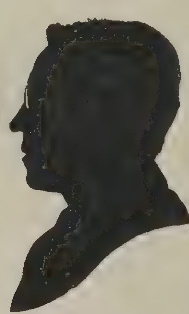
Safety Car Heat &
Ltg. Co., Chicago



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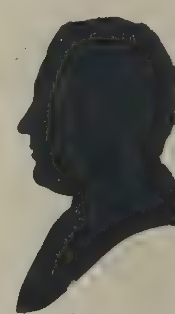

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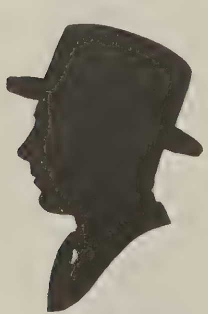
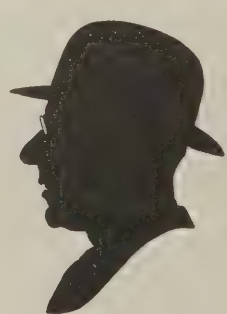
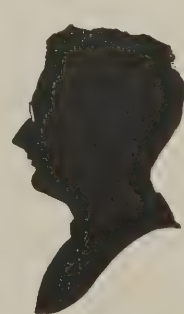
Safety Car Heat &
Ltg. Co., Chicago



A. V. Livingston
Safety Car Heat &
Ltg. Co., New Haven



J. L. Hays
Safety Car Heat &
Ltg. Co., Philadelphia



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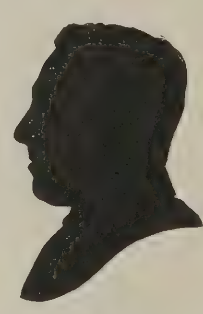
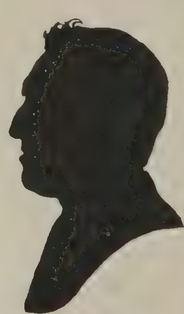
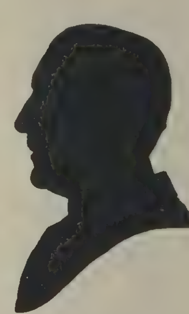
S. K. F. Industries,
Inc., New York



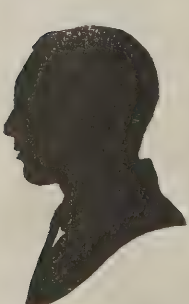
W. P. Pusey
S. K. F. Industries,
Inc., Milwaukee



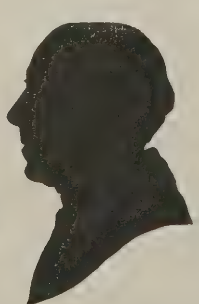
J. B. Castino
S. K. F., Industries,
Inc., Chicago



W. L. Gray
Stone Franklin Co.
Montreal

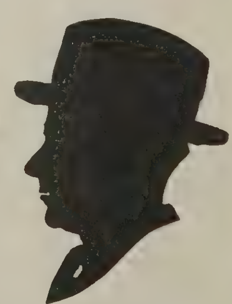


R. Girard
Stone Franklin Co.
Montreal

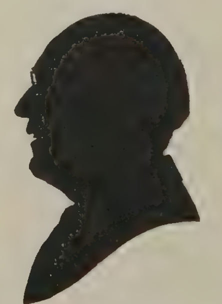


C. A. Robinson
Super-Safety Elec. Co.
Chicago

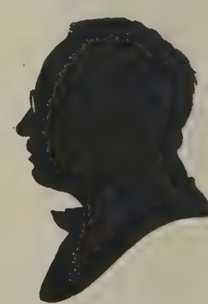
W. T. Manogue
Sunbeam Elec. Mfg.
Co., Philadelphia



J. H. Schroeder
Sunbeam Elec. Mfg.
Co., Evansville



H. A. Varney
Sunbeam Elec. Mfg.
Co., Chicago

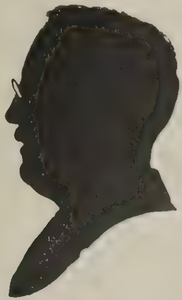


A. J. Thompson
Thompson Electric Co.
Cleveland

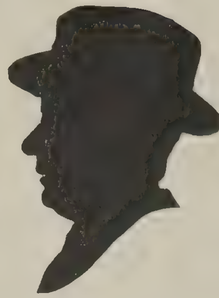
P. A. Garrity
Thos. A. Edison, Inc.
Chicago

W. A. Slack
Torchweld Equipment
Co., Chicago

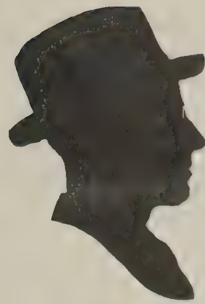
K. R. Hare
Transportation Engr.
Corp., Chicago



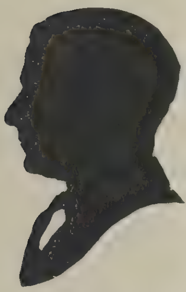
W. L. Bliss
U. S. Light & Heat
Corp., Niagara Falls



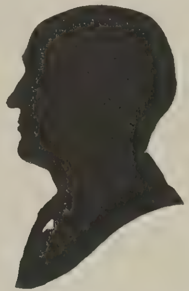
P. F. Lyons
U. S. Rubber Co.
Chicago



J. F. McDonnell
U. S. Rubber Co.
Chicago

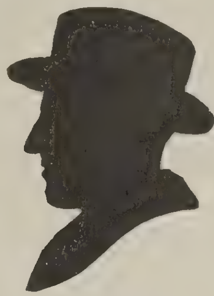


J. C. Stubbs
U. S. Rubber Co.
Chicago

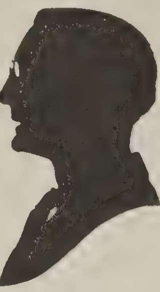


G. M. Haynes
U. S. Rubber Co.
Chicago

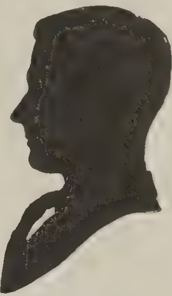
W. H. Dey
U. S. Radium Corp.
New York



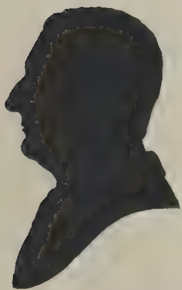
J. L. Carman
Western Elec. Co.
Omaha



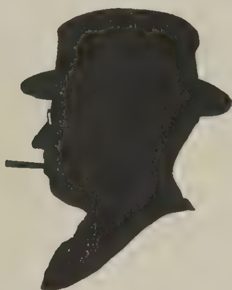
Otis B. Duncan
Western Elec. Co.
Chicago



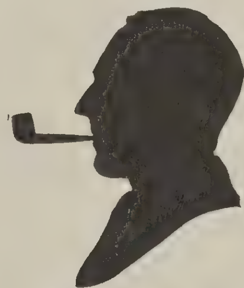
Wm. W. Reddie
West Elec. & Mfg. Co.
East Pittsburg



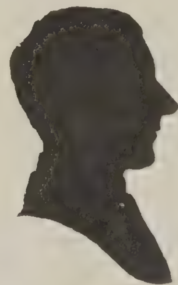
E. B. Reeser
Willard Stor. Bat. Co.
Indianapolis



Louis Sears
Willard Stor. Bat. Co.
Cleveland



C. E. Murray
Willard Stor. Bat. Co.
Chicago



A. E. Harrold
Willard Stor. Bat. Co.
Cleveland

fixtures and fans, also an electric water heater. A cutaway section of the Putnam battery was also on display. Represented by J. H. Rodger, C. A. Pinyerd, George H. Scott, R. S. Gay, Chicago; George E. Hulse, A. L. Livingston, New Haven; J. S. Henry, H. K. Williams, New York; J. L. Hayes, J. L. Marsh, Philadelphia; S. I. Hopkins, C. A. Chasey, St. Louis.

Railway Electrical Engineer, New York—At this booth were exhibited copies of the RAILWAY ELECTRICAL ENGINEER, together with a large display of different types of articles on various phases of electrical problems of the railroads. In this booth the representatives of the magazine made silhouette pictures of every visitor sitting in front of a 19-inch reflector headlight. As soon as a person found his likeness on the bulletin board he was handed a mounted copy of his silhouette. Represented by A. G. Oehler, C. J. Corse, New York; E. A. Lundy, Cleveland; G. Daves, J. H. Dunn, Chicago.

S. K. F. Industries, Inc., New York—Exhibited ball bearings for car lighting and headlighting generators, and a line of line shaft bearings with self-centering ball bearings, and also a line of self-centering roller bearings. Represented by W. B. Pusey, Milwaukee; J. B. Casino, H. A. Gumn, Chicago.

Sunbeam Electric & Manufacturing Company, Evansville, Ind.—This company exhibited Sunbeam airtight headlights and turbo-generators, together with a line of accessories for headlighting. Represented by W. T. Manogue, Philadelphia; H. A. Varney, Chicago, and J. Henry Schroeder, Evansville, Ind.

Thompson Electric Company, Cleveland, Ohio—Exhibited safety type cut out hangers for lamps and reflectors in shops, roundhouse yards, etc. Represented by A. J. Thompson, Cleveland, O.

U. S. Light & Heat Corporation, Niagara Falls, N. Y.—This company exhibited various types of car lighting regulating apparatus. A portable arc welding machine of 300 amp. capacity d.c.-d.c. with special weather-proof features was shown, together with samples of arc welding work. Represented by W. L. Bliss, H. A. Mathews and Ernest Bauer, Niagara Falls, N. Y.; A. W. Donop and H. A. Morrison, Chicago.

United States Rubber Company—Exhibited hard rubber jars, covers, separators and linings. A feature of the display was a new flexible compound battery jar and compound cover sealed on with parawax. Represented by L. S. Hungerford, Jr., P. Lyons, W. T. Keenan, J. C. Stubbs, George M. Haynes, J. F. McDonnell, Chicago and W. P. Foley, George A. Gardner, New York.

Western Electric Company, New York—Featured cast aluminum cases for flood lighting and beam lighting with new design of case to permit cleaning reflectors or changing the bulb without destroying adjustment. Electric drills, wire tape, etc., were also on exhibit. Represented by Otis B. Duncan, C. Ohlmstead, W. Davis, Chicago.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.—This company featured a new headlight generator, a new squirrel cage motor, a floodlight unit and an electric solder pot. A new a.c. automatic starter was also on exhibit. Represented by J. F. Hallowell, L. A. Spangler, G. T. Keech, Chicago; C. D. Pence, W. W. Reddie, A. M. Candy, East Pittsburgh, Pa.; J. H. MacMurchy, Philadelphia, and C. J. Stahl, South Bend, Ind.

Willard Storage Battery Company, Cleveland—This company exhibited carlighting, radio and signal storage batteries. A 12 a.h. storage cell with electrolytic rectifier for radio was the feature of the exhibit. Represented by A. E. Harrold, Louis Sears, Cleveland; C. E. Murray, P. J. Gribbon, Chicago; E. B. Reeser, Indianapolis, and M. J. Brennan, Detroit.

Daniel Woodhead Company, Chicago—Exhibited Diehl electric fans, Wheeler reflectors, Ackerman and Candee tapes and Non-fluid oil. Represented by Daniel Woodhead, E. J. Biederman, J. V. Conway and Stuart Standish, Chicago; W. C. Candee, New York, represented the Ackurate Rubber Company, Inc.

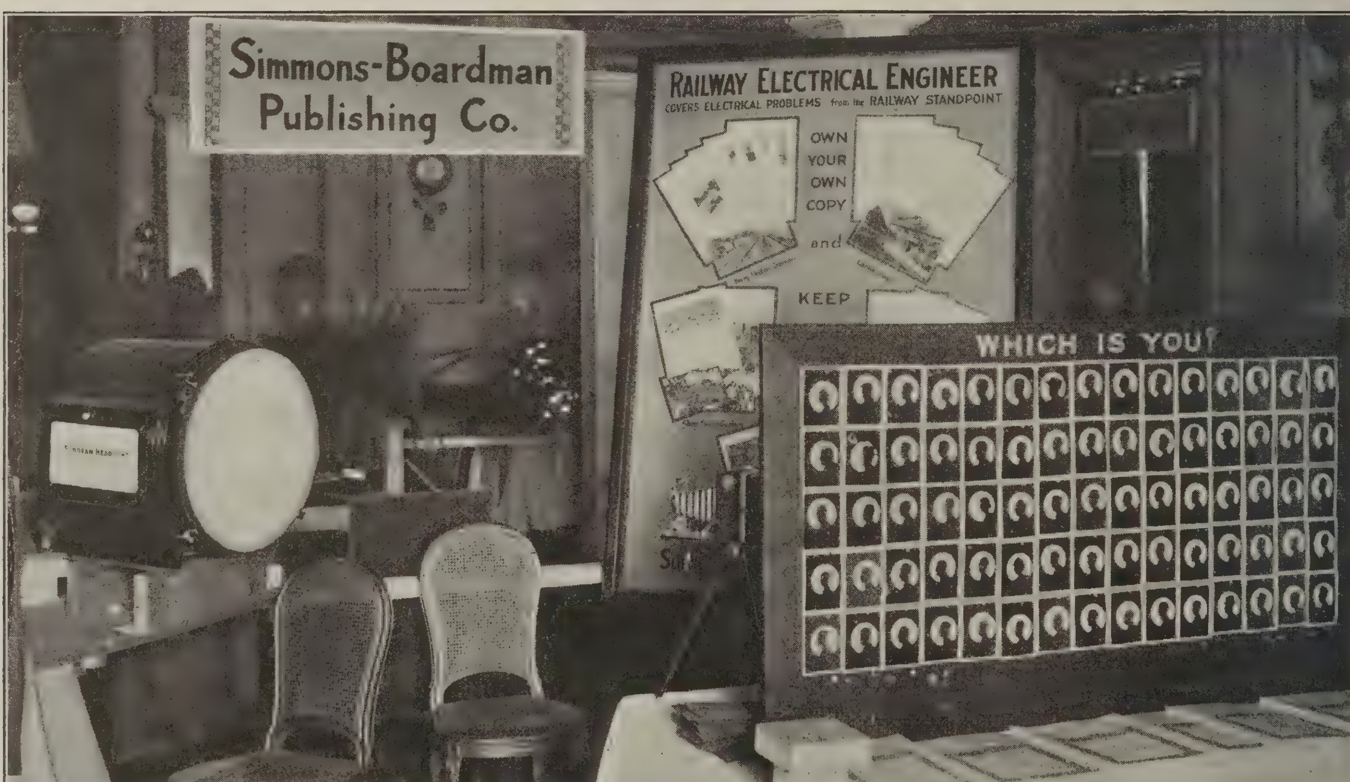
Both dry cells and storage batteries are manufactured by Chinese concerns in Shanghai. The products are inferior to imported batteries, but as cost is a controlling feature with Chinese buyers, many locally made cells are used.

How the Silhouettes Were Made

Readers of the *Railway Electrical Engineer* who were not so fortunate as to be able to attend the annual convention of the Association of Railway Electrical Engineers may be curious to learn the origin of the silhouettes published in this issue, and the following explanation is therefore included.

The *Railway Electrical Engineer* booth which was set up in the Hotel La Salle, Chicago, Ill., during the convention is shown in the illustration. A locomotive headlight with an 18-in. parabolic reflector was borrowed from the Sunbeam Electric Manufacturing Company and set up in one corner of the booth. A piece of tracing cloth was placed over the front glass of the headlight to diffuse the light. A chair was placed in front of the headlight and a small camera on the table opposite pointing directly at the headlight. The headlight was fitted with a 250-watt, 110-volt projection lamp.

Those present at the convention were invited into the booth, one at a time, and asked to sit in front of the light. Identification letters were secured through the tracing cloth near the top by means of rubber cement. These letters were changed for each subject. When the subject was in place, the light was turned on, the picture snapped with an exposure of about one-third of a second with a U. S. 8 diaphragm. Identification letters corresponding to those on the headlight were written down in a notebook or register and the subject, before leaving, wrote his name, title, company and address opposite the letters. As quickly as possible, the photographs were finished, two prints being made of each picture. One of these prints was mounted on the board shown in the foreground of the illustration, but the name and address of the person were not exhibited with it. It was left to those who had



The Booth in Which the Pictures Were Taken

had their picture taken to identify themselves as a silhouette on the board. As soon as they had done so, they were presented with the duplicate copy of their picture in a small souvenir folder.

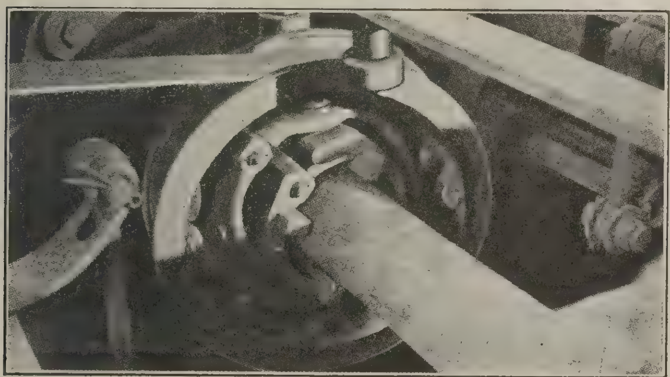
After the convention was over, the pictures were removed from the board and used for the purpose of making the silhouettes published in this issue in connection with the convention discussion and exhibit story.

The Krebs Universal Pulley for Axle Generator Drive

The Krebs universal split pulley wheel for axle driven car lighting generators, developed by the Krebs Manufacturing Company, was mentioned by the committee on train lighting equipment and practice at the convention of the Association of Electrical Engineers, held October, 1922. At that time one of the pulleys had been tried out on the Rock Island with highly satisfactory results. Since then the pulley has been improved and more tests have been made.

This pulley wheel consists of a two piece cast steel hub which is wedged positively to the truck axle by the use of four cast steel shoes and four steel tapered wedges.

The four shoes are placed in equal division around the axle. The four tapered wedges are then driven through



Side View Showing Method of Mounting Pulley on Axle

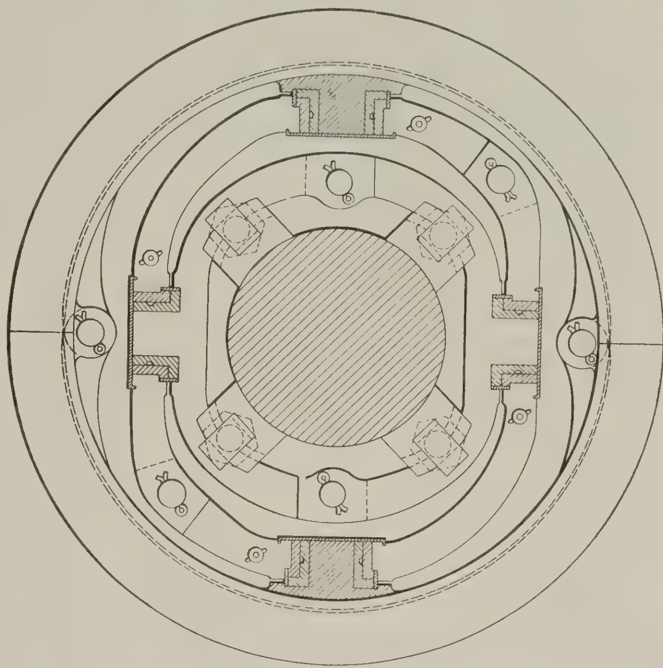
the key slots which are machined in both the hub and the four shoes. The tapered wedges are threaded on the small end for ¾-in. nuts which are drawn up firmly against the side of the hub and also the ends of shoes, making a positive firm contact with the axle.

The hub is made to clear the largest size axle and the difference in space between the inside diameter of hub and the largest size axle and space for smallest size axles is taken care of by furnishing various thicknesses of shoes for either straight or tapered axle.

The split ring spoke is made of cast steel and connected to the hub at two pivoted points with manganese steel bushings and pivoted pins or shafts, and is connected also to the outer flanged rim in the same manner only at diagonal points from hub pivot, making the movement of pulley wheel universal. The latitude of movement of the universal provides for the shortest radius curve that may be found in railroad practice. The outer rim has straight flanges 1½ in. deep and is 5⅛ in. wide between flanges for use of a maximum 5-in. belt.

The split rim, hub and spoke are connected securely by means of ¾-in. pins held in place by cotter pins. No bolts are used in the assembly.

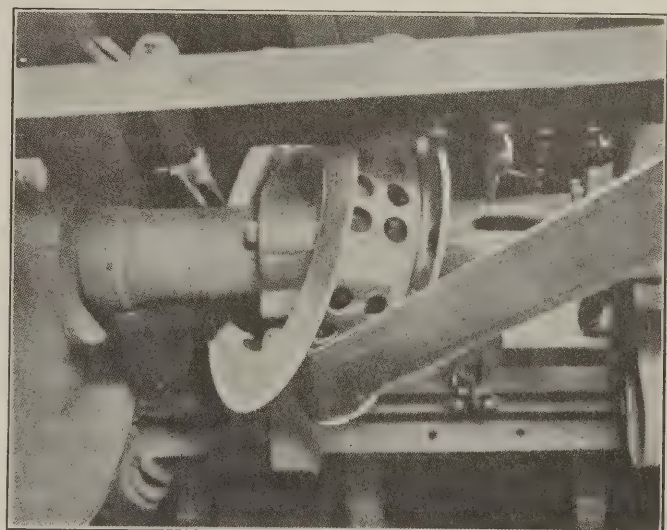
The pulley wheel is held vertical at all times by the use of guide rollers of manganese steel and which are applied to a cross bar which is controlled and floats with



Side Elevation of Pulley With Manganese Bearings and Car Axle Shown in Section

the side movement of axle by coming in contact with the inner side of edge of axle wheels. Two manganese steel pieces on the ends of the cross bar make frictional contact with the car wheels.

By this means of control, the pulley wheel is always



Pulley Mounted on Axle With Belt Pulled Out of Line to Show Action of Universal

kept in a vertical or upright position, and at the same time the guide allows the side movement of axle and regulates its direct universal movement so as to always be in line with the generator pulley regardless of the different movements between the car body and the truck.

The sliding bar or guide roller frame can be made and

applied in several different ways to meet requirements of different truck constructions and proper clearance under frame of cars. As it is placed on the truck it is unnecessary for it to be taken off when car wheels are changed.

All parts of the pulley are interchangeable and in case of wrecks or unusual cause of damage, any one or more parts can be secured.

The pulley is provided with the Alemite system of lubrication and the manufacturer states this will not require attention more than once or twice a year. The manganese steel bearings are supposed to need no lubrication but it is applied in order to provide a greater safety margin and hence secure the maximum life to the pulley. A special clamp or belt fastener is also supplied by the manufacturer.

The report of the A. R. E. E. committee on train lighting equipment and practice for 1923 contains the following statement concerning the pulley:

"The report of this committee last year contained a description of a belt drive using a universal axle pulley. This test equipment has now been in service since May 17, 1922, having made a total mileage of over 227,000 miles. The original belt (5" 4-ply) is still in service and during this period has been shortened four times. A special flexible type of belt fastener is used which was specially developed for use with this drive. The report indicated that the pulley belt and fastener are still in good condition."

Test Plug Permits Reading on Motor While In Operation

The Industrial Controller Company, Milwaukee, Wis., has placed on the market a new style disconnecting switch and test jack combined, for use with automatic or manually operated compensators.

This device has been developed as a result of a long felt need on the part of electrical engineers in charge of power equipment, for a quicker and more economical means of checking the load conditions on motors and lines. To insure continuous and efficient production, motors should produce their rated output with a margin of safety to prevent brakedowns. Accurate information as to power factor, line capacity, and power required for each machine, is therefore necessary.

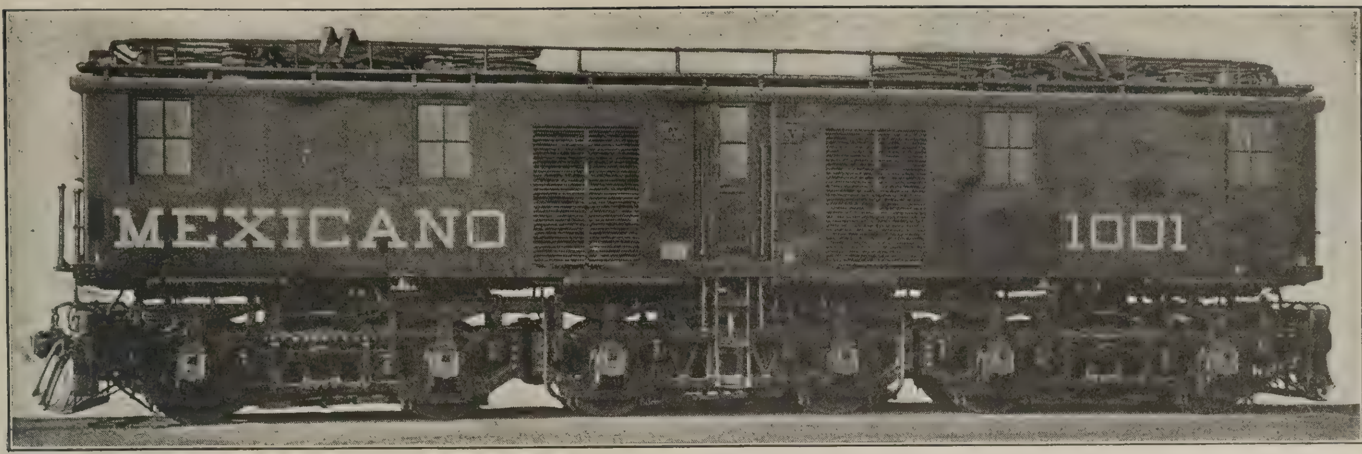
The switch is arranged for mounting either at the top or at the bottom of the compensators and is held in place by conduit connectors through the knockout holes. This makes a very compact unit and saves the cost of running conduit between the compensator and the switch. It is mounted on a slate base and is enclosed in a steel cabinet, the cover of which cannot be removed when the switch is closed. The switch is of the quick double make and break type with wide break distance and powerful spring action. The contacts are similar to those used in drum controllers and both the movable and stationary contacts are renewable.

There are three insulated openings in the front of the switch cabinet for inserting the test jack plug. These openings are protected by a hinged cover. When the test plug is inserted, it passes between the lower jaws of the switch and is firmly held by the spring tension of the fingers. Each leg of the plug consists of two strips of copper with a layer of insulating material between. Wires are connected to each of the copper strips, so that ammeter, voltmeter, or wattmeter readings may easily be taken.

When an installation is equipped with test jack switches, the necessary measuring instruments are attached to the test plug with a long six wire cord. The electrician can insert the test plug in the switch and take the necessary readings without stopping the motor or disturbing the operator.

Disconnecting Switch Mounted Above Controller with Cover Removed Showing Construction of Switch. Test Plug in Place. Test Plug Can Also be Applied Through Insulated Holes in Cover When Cover is in Place.

St. Gotthard Railway in Pfaffensprung Gorge



One of the Ten Electric Locomotives Being Built for the Mexican Railways

Ten Locomotives Being Built for Mexican Railway

One Type of Motive Power Unit Will Be Used for Both Passenger and Freight Service

By Glen H. Walker
Railway Engineering Department, General Electric Company

THE General Electric Company and the American Locomotive Company are furnishing ten 150-ton, 3,000-volt direct current electric locomotives for the initial electrification of the Mexican Railway Company. The tests on the first of these are now nearing completion at the Erie works of the General Electric Company.

The Mexican Railway Co., Ltd., is one of the oldest railway companies operating in Mexico. Its main line runs between Vera Cruz on the Gulf of Mexico and Mexico City. A section of this line between Orizaba (about 70 miles inland from Vera Cruz) and Esperanza, a distance of 30 miles, is now being electrified. This section is known as the Maltrata Incline and includes the most scenic country in Mexico. Mt. Orizaba, 18,225 feet in height, is visible from almost all points in this section and has snow at its peak the year around.

It is said that the construction of the Maltrata Incline of the Mexican Railway was one of the most difficult pieces of railway engineering attempted in North America. Because of the mountainous country through which the railroad passes from the sea level at Vera Cruz to the great Mexican plateau—a change in elevation of some 8,000 ft. in 100 miles—many severe grades and sharp curves are encountered. A change of 4,000 ft. in elevation is made in the 30-mile section which is now being electrified.

Service

The locomotives will be used in both freight and passenger service between Orizaba and Esperanza. Freight trains of 700 tons weight will be taken up the grade with two locomotives, one at the head end and one at the rear of the train. Trains of about the same weight will be brought down the grade with one locomotive by regenerative electric braking. Speeds both up and down grades for freight trains will average about 15 miles per hour.

All but an occasional passenger train can be taken over the grades by a single locomotive. For passenger trains requiring more than one locomotive two units will be used operating at the head end under the control of one engineman. As it is considered unsafe to run trains down these grades and around the sharp curves at greater than 20 m. p. hr. the same locomotive with the same gear ratio as that used for freight service will be used for passenger service. The speeds of the passenger trains will average about 18 to 20 m. p. hr. both up and down grades, although the locomotives can operate at a maximum speed of 33 m. p. hr.

The locomotives are rated 04440-E-308-6GE278A-3,000 volts direct-current, having characteristics and dimensions as listed in the table.

GENERAL DATA

Electrical Data	
Nominal voltage of system	3,000 volts, d. c.
Tractive effort 1 hour blown (3,000 V.)	54,300 lb.
Speed at 1 hour rating	20 m. p. hr.
Total horsepower, 1 hour	2,700
Tractive effort continuous 3,000 V.	46,200
Speed at continuous rating, 3,000 V.	20.5
Total horsepower, continuous	2,500
Number of motors	6
Type of motors	GE-278-A-1,500/3,000 V
Gear ratio	90/18–5.00
Tractive effort at 30 per cent tractive coef.	92,400 lb.
Mechanical Data	
Track gage	4 ft. 8½ in.
Wheel arrangement	04440
Diameter of drivers	46 inches
Number of driving axles	6
Total wheel-base	40 ft. 6 in.
Max. rigid wheel-base	9 ft. 2 in.
Width overall	10 ft. 1½ in.
Height over trolley locked down	15 ft. 2 in.
Length inside knuckles	52 ft. 11 in.
Weights	
Total weight on drivers	308,000 lb.
Weight per driving axle	51,300 lb.
Dead weight per axle	12,150 lb.
Elec. and air brake equipment	135,000 lb.
Mechanical equipment	173,000 lb.

Mechanical Features

A single cab is mounted on two equalizer frames which in turn are carried upon three two-axle articulated trucks.

A motor is geared direct to each axle with twin spring gears.

The cab is of the box type, built up of 1/8 in. steel sheet, riveted to structural framework, on a platform of structural steel longitudinal and cross sills, stiffened by bolster bars and a 3/8 in. steel floor plate. The cab is 47 ft. 6 in. long by 10 ft. wide and divided into an apparatus compartment and an engineman's cab 5 ft. long by 10 ft. wide at each end. The apparatus compartment houses the high tension control apparatus and the auxiliary machinery. Doors and windows are located to provide light and access to the cabs and apparatus compartment. Louvers are located on each side of the side doors to admit air to the cab for the blowers.

The three trucks have steel side frames to which the end frames carrying the draft gear and articulated joints are bolted. The superstructure is carried on center plates on the truck transom bolted to the side frames at their midpoint and the whole is carried on equalized semi-elliptic springs as has been satisfactorily used on locomotives for the Butte, Anaconda & Pacific, the Chicago, Milwaukee & St. Paul, the Baltimore & Ohio and others. Buffing and hauling stresses are carried through the side frames and the articulated joints.

The leading and trailing trucks are equipped with Miner Friction A-18 draft gear and Simplex couplers with 5 in. x 7 in. shank, 9 1/8 in. butt, and 9 in. solid knuckle. The couplers are located a distance of 34 1/2 in. above the rail head.

Motors

To each of the six axles there is geared a box frame, twin geared, commutating pole, GE-278-A-1500/3000-volt, railway type motor with forced ventilation. These motors are designed to operate two in series on 3,000 volts or with 1,500 volts per motor, but each is insulated for 3,000 volts to ground. Each motor is supported on its axle by suspension bearings and on the transom by a spring nose support giving a clearance under the gear case with new wheels and axle linings of 4 1/4 in. An 18-tooth forged steel pinion is mounted on each end of the armature shaft which meshes with a 90-tooth cushion type gear on the axle. The cushion type gear is designed to permit a small movement of the rim about the gear center which tends to equalize the stresses in the gears and pinions and to minimize the shocks on the teeth.

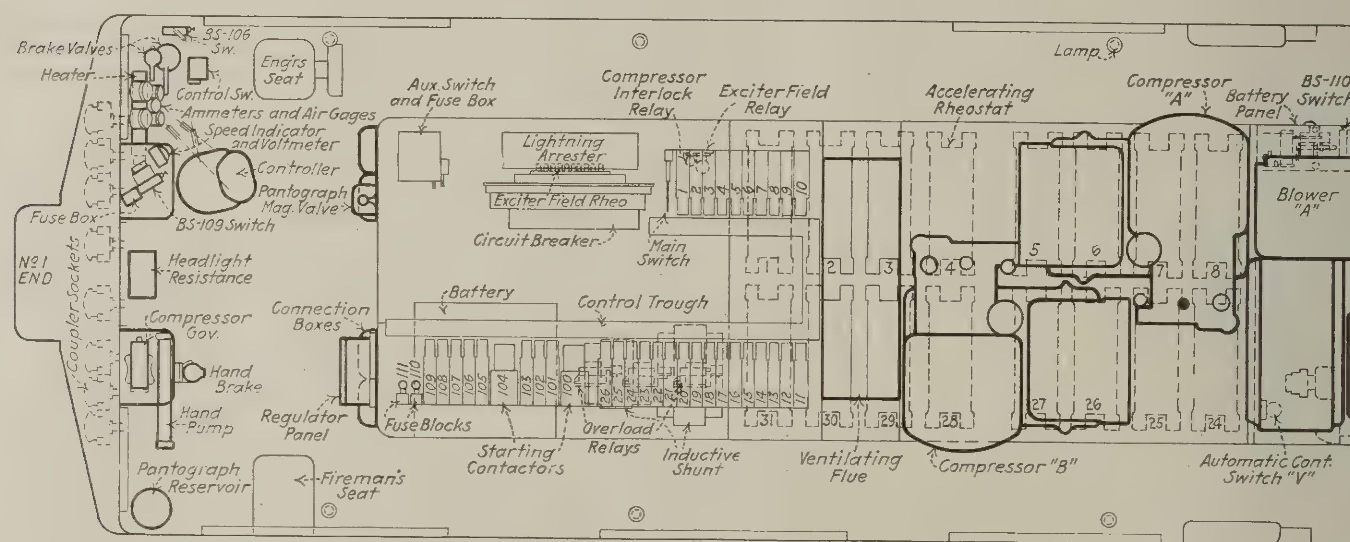
Auxiliary Machinery

The auxiliary machinery consists of a 3,000/1,500 volt dynamotor which has a 4 kw., 65-volt control generator mounted on a shaft extension, a 1,500-volt regenerative exciter set, two 1,500/3,000-volt motor-driven blowers and two 1,500/3,000-volt air compressors. The dynamotor provides 1,500-volt power for operation of the blowers, compressors, and the regenerative exciter set. The two blower motors and the two compressors will normally be operated in series across 3,000 volts with their mid-points connected to the mid-point of the dynamotor for equalization. The regenerative exciter will be operated from the 1,500 volt point on the dynamotor to ground. If it is not required to operate the blowers at their maximum capacity, they may be connected in series and operated from the 1,500-volt dynamotor bus to ground.

The control generator mounted on the dynamotor shaft extension furnishes current at 65 volts for lights, headlights, foot warmers, control circuits and for charging the storage battery.

The two air compressors are of the two-stage horizontal cylinder type and have a total piston displacement of 150 cubic feet per minute when delivering air against 130 lb. pressure and operating two in series on 3,000 volts.

The scheme of auxiliaries outlined above was chosen for this locomotive as it provides means of operating one compressor or one blower from the 1,500-volt dynamotor bus in case of failure of the other machine. It also provides means of operating the compressors and blowers in case of failure of the dynamotor which could not be done if low voltage auxiliaries were operated from a 3,000-volt motor-generator set. A further advantage is in the fact that a dynamotor is inherently a stable machine and not subject to flashing due to short circuits and sudden changes in trolley voltage.



Plan of No. 1 End of Locomotive Showing Location of Apparatus

Air Brake

The air brake is Westinghouse No. 14 EL, double end, straight and automatic equipment including air signals. This equipment is arranged for double-heading locomotives and provision is made to prevent application of the

air brakes on the locomotive during regenerative braking while the brakes may be applied on the train. This feature enables a single locomotive to bring a much heavier train down grade under the control of regenerative braking and air brakes than could be brought down under the control of regenerative braking alone. In case of an emergency application of the air brakes during regenerative braking, regeneration is automatically shut off allowing the air brakes on the locomotive to apply in the usual manner.

Control

The locomotives are equipped with type P. C. L. electro-pneumatic control for non-automatic, multiple-unit operation. A master controller is located in each engineman's cab at each end of the locomotive and arranged to give 15 accelerating steps, one full field running step and two reduced field running steps with six motors in series in one group, nine accelerating steps, one full field running step and two reduced field running steps with three motors in series in two parallel groups, and seven accelerating steps, one full field running step and two reduced field running steps with two motors in series in three groups in parallel. This gives a total of nine running points which for a given tractive effort of 50,000 lb. and 2,700 volts line correspond to speeds of approximately 5, 4, 6.0, 6.75, 11.4, 12.8, 14.2, 17.4, 19.6 and 21.6 miles per hour.

Regenerative braking on the down grades is accomplished by exciting the fields of the traction motors by the regenerative exciter. Fifteen regenerating steps are provided for on the master controllers for each of the three motor groupings. These permit continuous regeneration at values of speed and braking effort within the safe operating limits of the motors.

The main motor circuits are protected by a quick-acting circuit breaker placed in the main circuits ahead of all accelerating contactors, etc. This breaker serves as a line breaker as well as to give overload and short circuit protection. On overloads it trips out due to the action of overload relays and on short circuit it opens on a sudden rise in the value of the current flowing through it.

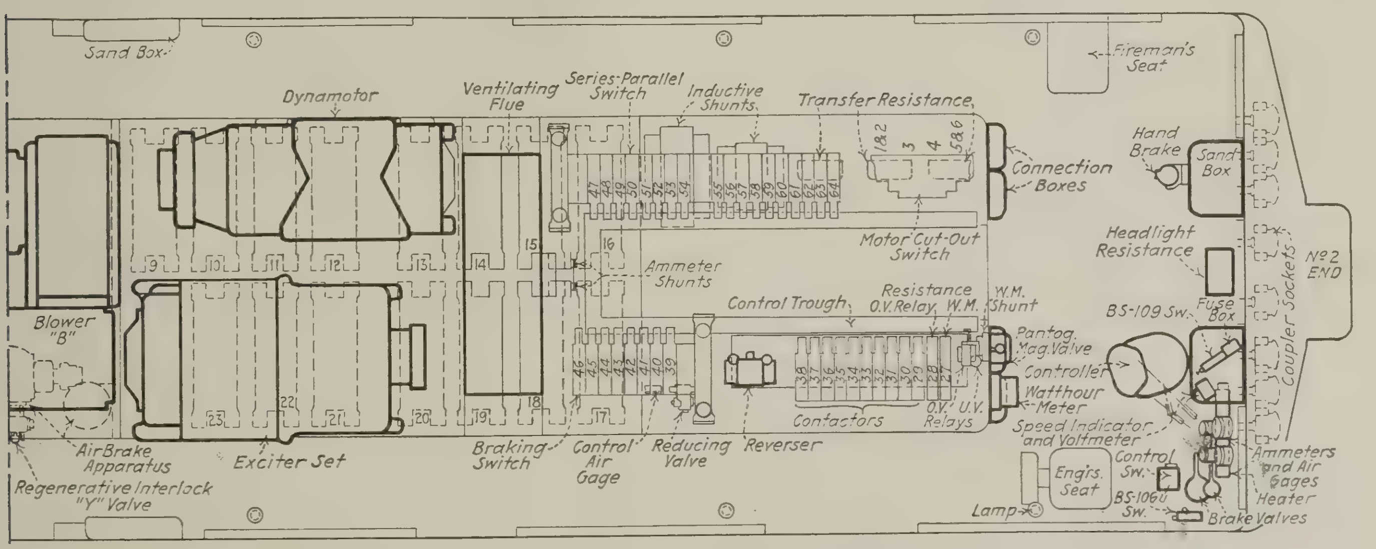
The auxiliary apparatus is controlled by electro-magnetically operated contactors which are operated by push-button switches within reach of the engineman at either operating position.

Current is collected from a centrally located overhead conductor through one or both of two slider pantograph trolleys located on the roof of the locomotive one at each end. These trolleys have a range of from 15 ft. 5 in. to 24 ft. above the rail. They are raised and held against the wire by air pressure and are retracted by gravity when the air pressure is released. Air is admitted to or exhausted from the trolley cylinders by a magnet valve which is operated by a push-button switch at the operating position. The engineman can raise or lower either or both trolleys by these switches at either position.

The locomotives are equipped with air-operated whistles, bell ringers and sanders which are controlled by valves at the engineman's position. Ammeters, a voltmeter and a speed indicator, as well as the usual air gages, are mounted on panels within the engineman's view.

Arrangement of Apparatus

The apparatus compartment is divided up into a rheostat compartment and two control apparatus compartments. The rheostat compartment extends each way from the center of the cab about one-half the length of the apparatus compartment and is approximately three feet high. Near each end a ventilating flue extends from this compartment to ventilators on the roof which serve to carry off the heat generated by the rheostats.



Plan of No. 2 End of Locomotive Showing Location of Apparatus

The roof of the rheostat compartment is insulated against heat and used as a shelf upon which the auxiliaries are mounted and conduits are run carrying cables between the control compartments and from the control compartments to the taps on the rheostats. The latter cables are carried from the conduits through the roof of the rheostat compartment in porcelain bus lugs.

The location of the auxiliaries in the middle and on top of the rheostat compartment makes them very easily inspected from the side aisles and keeps the noises of the running machines out of the engineman's cab.

The control apparatus compartment on No. 1 end contains the main switch, quick-acting circuit breaker, lightning arrester, other protective apparatus and some of the accelerating contactors. These pieces of apparatus are located so that there is a center aisle in the compartment

giving very good access to the apparatus. This aisle is entered from the engineman's cab and is on the same level.

The control apparatus compartment on No. 2 end is similar in arrangement to that on No. 1 end and contains the cam switches for grouping the motors for the different motoring regenerating combinations, the reverser, the motor cut-out switches and the remainder of the accelerating and field-reducing contactors.

The high voltage connections to the apparatus in both compartments are made at the back and are accessible by removing compartment covers into the side aisles. The low voltage control connections are made at the front of the apparatus and the wires are carried in a control trough running in front of the apparatus.

The American Locomotive Company has completed shipment of the 10 mechanical portions of these locomotives from their Schenectady plant. The installation of equipment and tests are being made at the Erie, Pa., plant of the General Electric Company and it is expected that five complete locomotives will have been routed to the Mexican Railway Company at Orizaba by the first of the year. The remaining five locomotives will be completed before the first of March so that electric operation may be started early in the spring of 1923.

Test of Train Control on the Chicago & Alton

A DEMONSTRATION of the Chicago & Alton train control installation between Normal, Ill., and Lexington, on October 11, was attended by representatives of 18 roads with a total of 41 present. A special train consisting of two business cars, a coach and an Atlantic type locomotive left Bloomington, Ill., at 1:45 p. m. and returned to the station at 4:30 p. m.

The intermittent inductive train control system of the National Safety Appliance Company as described in the

C. & A. Passenger Locomotive Equipped with National Safety Appliance Company's Apparatus

Railway Electrical Engineer for May, 1922, is in service on this 14 miles of double track, with track magnets located at the signals, which are provided with an overlap to provide proper braking distance. At 11 locations a simple automatic stop feature is used, while at one location (the first signal north of the southbound distant signal at the Normal interlocking plant), the track sections are arranged for a speed control of 40 m.p.h. through the yards. The use of this magnet for such a purpose is a special application of the system and this speed restriction is independent of the signal indication. The same features may be used where it is desirable to enforce speed restrictions on approaching a crossing or at any other point.

At this same interlocking the southbound distant signal is equipped for speed control only, with a limit of 30 m.p.h. in order to compel the engineman to approach the home signal under control. Four locomotives are equipped

One of the Signal Locations Showing the Track Inductors

with the automatic train control apparatus, two of which are in passenger service and two in freight service.

Tests Prove Satisfactory

In the first test, signal 146 was at "proceed," while the track magnet was purposely disconnected to give a surprise test. The location was approached at a speed of 58 m.p.h. and the train was brought to a stop by an application of the brakes in a space of 2,211 ft., during which period no action was taken by the engineman, the engine working steam all the while, thus stimulating a dead man test.

Test No. 2 was made at signal 144 at a speed of only 2 m.p.h. to demonstrate the ability of the apparatus to operate at very low speed. On this second test the signal was put at "stop" with the track magnet de-energized and the brakes were applied automatically on passing the track element.

Test No. 3 at signal 142, was another high speed test similar to test No. 1, the train being operated at 58 m.p.h. On passing the track magnet the train was stopped automatically in approximately 2,400 ft., with the steam working and traveling on a descending grade.

In the next test, which was a zero speed test, the receiving element on the locomotive was spotted directly over an energized track magnet. The magnet was then purposely de-energized to see if an automatic brake application would result. This caused a brake application and the locomotive could not be moved from its position without bleeding the train line. However, the brakes could have been released promptly by breaking the seal and manipulating the hand release valve on the stop valve in the locomotive. The broken seal would then show that the device has been operated in service.

On all tests either at high or low speed over track magnets which were at "clear" the apparatus functioned as designed, *i.e.,* no automatic application of the brakes was made.

Lighting of New C. R. I. & P. Suburban Coaches

Automatic Switching for Either 64-Volt or 32-Volt Train Line Voltage, With Emergency Light from Battery

By A. E. Ganzert
District Electrical Supervisor, Chicago, Rock Island & Pacific,
Des Moines, Ia.

THE Chicago, Rock Island & Pacific is placing in service 50 new all-steel passenger coaches. The total length of the car is 70 ft. 4 in., having a seating capacity of 100 passengers, there being 42 two-passenger cross seats and 4 end seats with room for four persons. The end doors and steps are extra wide, permitting two lines of passengers to pass out at once.

The Rock Island suburban car lighting service utilizes a Type M. 7.5 kw., 64-volt, d. c., Pyle National turbo-generator, having collector rings for furnishing 32 volts a. c. for the locomotive lamps. Occasionally a suburban car is attached to the rear of a regular main line train, therefore the car-lighting equipment was so designed that the connections will be automatically made for utilizing 32 volts on the lighting circuit instead of 64 volts. To this end, each of the new steel suburban cars is equipped with an especially designed automatic selector switch. This switch automatically causes the proper voltage to be impressed upon the lamps, regardless of whether the current supply to the car through its train line connector is 64 volts or 32. This switch operates in conjunction with a manually controlled master switch which is the only part of the entire equipment that is accessible to the trainmen. This is a four-position switch with the lever operating in one direction from the first step, which is the off position. The second step is the full on position, the third step is the first emergency position and the fourth step is the second emergency position. This switch is plainly stenciled to insure proper operation by the trainmen.

Fig. 1—Interior of One of the Coaches Showing Arrangement of Lighting Fixtures

Each car is equipped with a 32-volt, U. S. L. 80 amp. hr. storage battery, Fig. 2, which is floated on the train lines through a resistor *X*, shown in Fig. 4. This battery is so connected that in case of failure of the current supply from the engine, that its current is available for the lamp circuits, it only being necessary for the trainmen to throw the four-position master switch into one of the two emergency positions. The connection of the wiring to the four-position master switch is such that should he fail to secure light when he places the switch handle in the first emergency light position, he has only to push it on a little further to the second emergency light position when light will be secured. There are 13, 25-watt, 32-volt type C lamps on each side of the car with Safety type shade holder fixtures and Oliver E. & M. Company special bases having terminal blocks for making connections. The lamps are so connected in series-parallel in alternate pairs that when the master switch is in either of the two emergency positions that only one-half of all the lamps in the car are lighted.

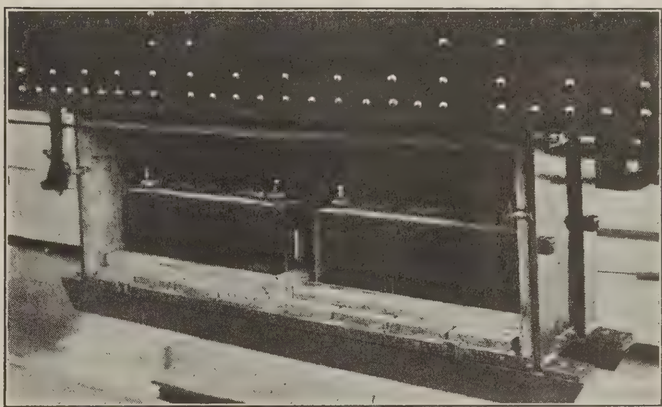


Fig. 2—An 80-Ampere-Hour Storage Battery is Used for Emergency Lighting

An even distribution of the lighting, however, is maintained due to the method of wiring and location. This emergency lighting arrangement affords ample lighting for the car by having all the lamps in the car connected to one or the other of the two emergency circuits. It is always possible in case of failure of one circuit to still supply ample light to the car with the other circuit and at the same time maintain an even distribution of the light.

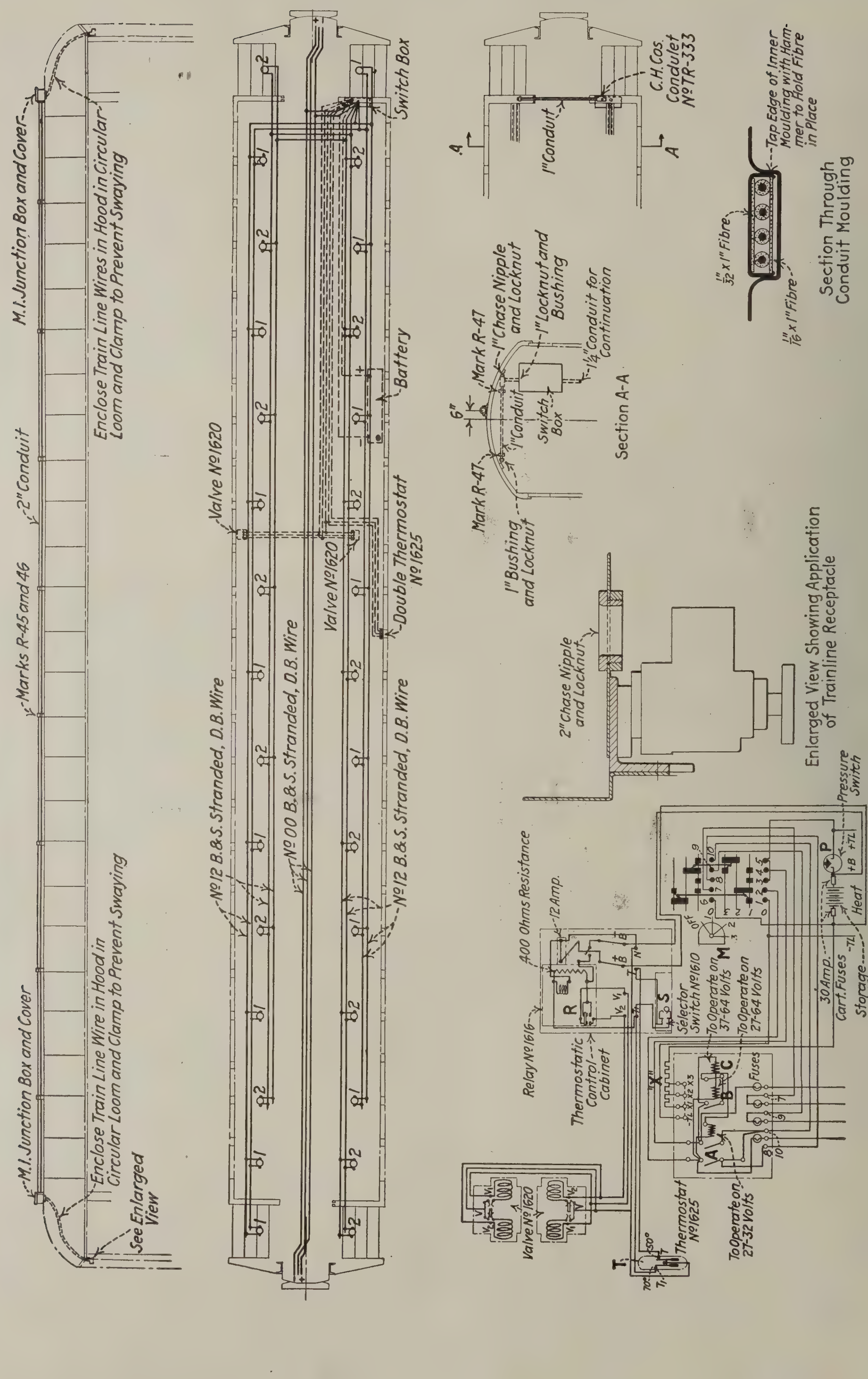


Fig. 3—Diagrams Showing Arrangement of Conduit Runs and Wiring of Control Circuits

Inasmuch as the battery with which these cars are equipped is used primarily to control the heating system and only serves in an emergency for lighting, a small size, light weight battery, as shown in Fig. 2, is used. The lighting equipment includes an air-operated switch that disconnects the lighting circuit from the battery, when there is no air on the car, so that the battery cannot be discharged when cars are standing in yards.

Unusual Control Circuits

Referring to the wiring diagram of the lighting circuits in Fig. 3, it may be seen that alternate lights in each row

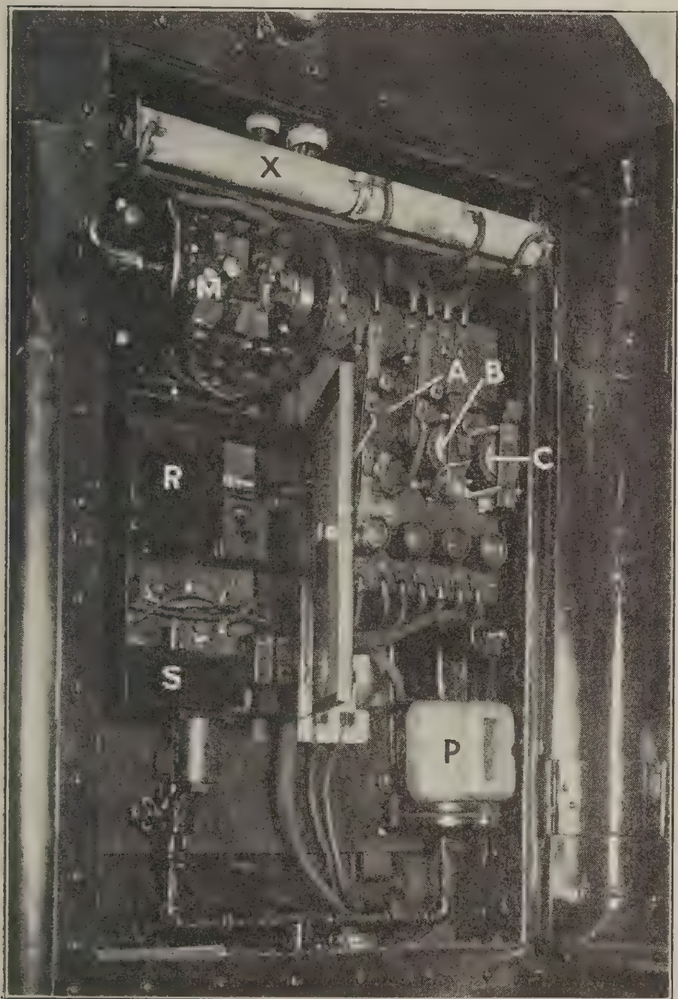


Fig. 4—Controller Panel With Covers Removed

are connected to separate circuits. These four No. 12 flexible insulated wires on each side of the car are run in steel conduit moulding, which is shown in the interior view of the car.

The four-position master switch shown at *M* in the picture of the control panel, Fig. 4, performs an unusual function. By tracing out the wiring it is seen that with this switch in the off position that the lights are all cut off, no matter if energy is supplied to the train line or not. In position 1, the lights are all lit no matter whether 64 volts from the end generator is supplied to the train line or if the 32 volts from an axle-light system of an adjacent car is connected to the train line. Of course, for a 64-volt feed the two sets of multiple lights are connected in series, but with the 32-volt the sets are in parallel. This automatic switching from the series to parallel connection or vice versa is accomplished by the operation of the selector switch at the right in the cabinet. The two-pole automatic contactor *A* operates on from 27 to 32 volts and is closed when a 32-volt pressure is applied to the train line, being controlled through the relay *B*, which closes at 27 volts. However, should the train line be connected to the 64-volt locomotive generator the relay *C* operates, thus opening the operating circuit of contactor *A*, causing same to remain in the normal or 64-volt position. In which position the two sets of lamps are in series.

In case the turbo-generator on the locomotive should fail in service or should the train line connectors fail, then either one set of lamps can be lighted by energy from the 80 amp. hr. storage battery by moving the master switch to one of the emergency positions. In case of a blown fuse in the first emergency circuit, light may be secured by moving the faster switch to the second emergency position. The pressure switch *P*, operated by train air pressure, prevents the emergency lights being turned on unless the car is connected in a train with air pressure on the air brake system. This feature

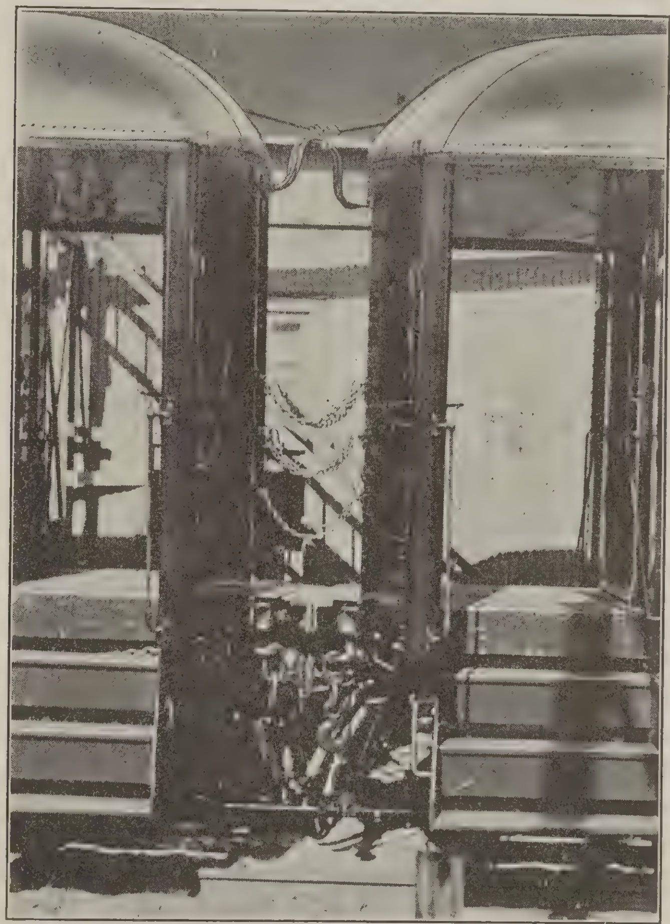


Fig. 5—Train Line Connectors Are Supported by Special Coil Springs Holding Up the Slack

prevents the lights being turned on when the coaches are in the yard, which would soon exhaust the battery.

The train line connectors when in service are supported by two coil springs fastened to the connector with harness snaps which keep the slack pulled up in the clear, as shown in Fig. 5. The three-wire train line of No. 00 B. & S. stranded insulated wire is carried over the top of the coach in 2-in. conduit and terminates at the ends in three-wire

Oliver type outlets. As shown in the diagram, the wires are carried through the hood at the ends of the car in loom.

The heating system is of the vapor type manufactured by the Vapor Car Heating Company. The double temperature thermostatic control for heating is entirely automatic and does not require the attention of the train crews or yard men. It maintains the temperature of the car between 70 deg. and 73 deg. while in train service and at 50 deg. while standing on steam in the yards. The change from 50 deg. to 70 deg. is made by the air-operated selector switch *S*. This obviates heating cars to high temperatures while idle and over a period of time will save considerable fuel. The cabinet control switch is turned on at all times during the heating season.

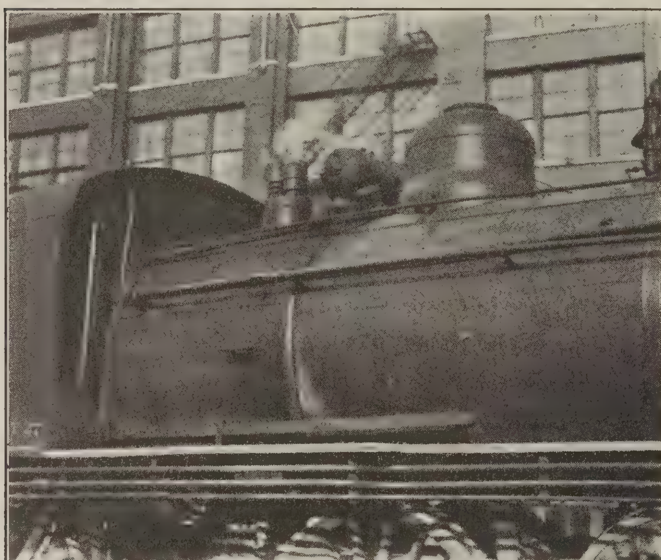


Fig. 6—C. R. I. & P. Suburban Locomotive Showing the Mounting of the 7.5 Kw., 64-Volt Turbo-Generator

By again referring to the circuit diagram it may be seen that the thermostat *T* controls contacts that in turn operate the automatic magnetic control switch *R* in the cabinet which controls the electro-magnetically operated steam valves, thus admitting or cutting off steam to the heating system of the car.

Electric Locomotive Tested at 105 Miles an Hour

SPEED tests of the new type electric locomotive built by the General Electric Company and the American Locomotive Company for the Paris-Orleans Railway, were held December 4 and 5 at Erie, Pa., before a large gathering of railway representatives.

In order definitely to determine the riding qualities of this locomotive, a large number of runs were made over the 4½ miles of test track at Erie, operating at speeds between 60 and 80 miles an hour. On one test the locomotive made a sustained speed for a distance of about one mile of 95 miles an hour, the locomotive running light. On a preliminary test made December 2, the locomotive was run at 105 miles an hour.

Guests were carried in the forward and rear cabs, where they observed the riding qualities of both ends and also observed speed indicators and other instruments. The locomotive operated successfully at these high speeds and there was no indication of periodical oscillation or nosing. The tests included critical observation of both the front and rear of the locomotive, and there was no apparent tendency toward any objectionable movements which might have injurious effect upon the track. Records were also obtained by means of the Otheograph, which indicated unusual freedom from nosing at high speeds. Examinations were made of the track after these runs and showed absence of any detrimental effects.

The commutation of the motors was observed under all operating conditions and reported to be excellent. Other tests included commutation tests with rapidly changing trolley voltage and wheel slipping with and without sand.

The locomotive was designed for the purpose of supplying a unit having approximately 80 tons on drivers and having a maximum free running speed of 80.8 miles an hour. The locomotive was ordered by the Paris-Orleans Railway from the Compagnie Francaise Thompson-Houston, the International General Electric Company's associated manufacturing company in France. The Compagnie Francaise Thomson-Houston has received orders for more than $15,000,000 worth of equipment for this electrification and orders aggregating $2,500,000 have been placed through the International General Electric Company with the General Electric Company in the United States.

The locomotive is of the gearless type, having two three-axle driving trucks and a two-axle guiding truck at each end. The control and auxiliary equipment is carried in two box cabs, each of which is attached rigidly to the driving truck. The three-axle driving trucks are connected by an articulated joint and each guiding truck is articulated at its inner end to the main truck. At its outer end, the forward portion of the cab is supported on a double roller centering device. The motor fields and frames are constructed to form an integral part of the truck frame and running gear and the armatures are mounted directly on the driving axles. Current is collected from an overhead trolley approximately 20 ft. above the rail by means of the usual sliding pantograph, one of which is mounted on each cab.

General dimensions and data are given in the following table:

Electrical Data

Nominal voltage of system	1,500 volts, d. c.
Average line voltage assumed	1,350 volts.

	One Hour	Continuous
Rated Tr. Eff. (1,350 V.)	14,586 lb.	12,540 lb.
Speed at rating (1,350 V.)	60 m. p. h.	63 m. p. h.
Total horsepower*	2.370	2,130
Number of motors	6	
Type of motors	GE-101-A	
Voltage of motors	750	
Tractive effort at 30 per cent tr. coef		47,960 lb.

Mechanical Data

Track gage	56½ in.
Diameter of drivers	47.2 in.
Number of driving axles	6
Diameter of guiding wheels	36 in.
Number of guiding axles	4
Total wheelbase	53 ft. 6 in.
Max. rigid wheelbase	9 ft. 3½ in.
Width over-all	9 ft. 6 in.
Length over buffers	62 ft. 0 in.
Height over trolley locked down	12 ft. 6 in.

Weights

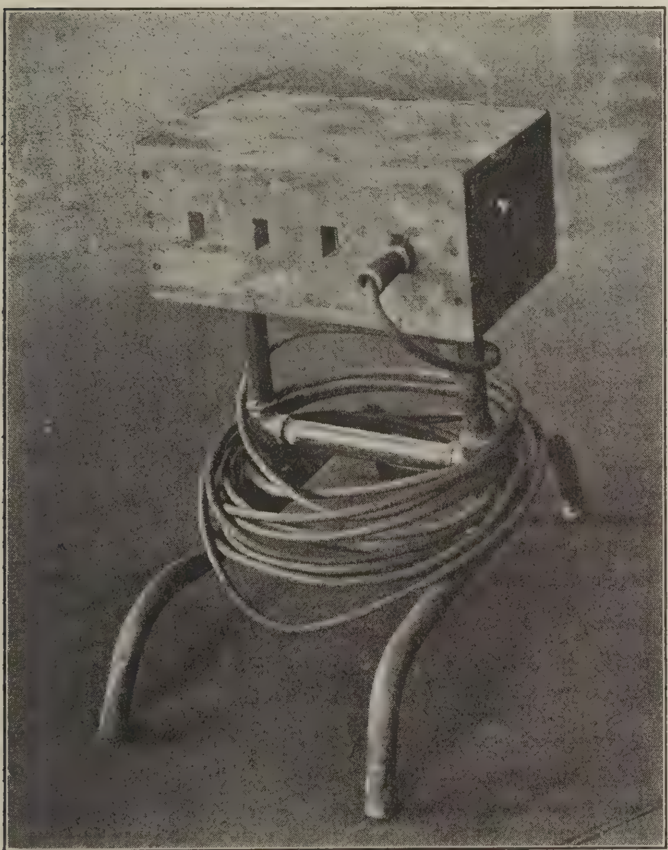
On drivers	159,720 lb.
Per driving axle	26,765 lb.
Dead weight per guiding axle	9,064 lb.
On guiding axles	79,200 lb.
Per guiding axle	19,690 lb.
Elec. and air brake equipment	102,880 lb.
Mechanical equipment	138,600 lb.
Total weight	238,480 lb.

*French horsepower = 736 watts.

Multiple Extension Outlet

The multiple extension outlet shown in the illustration is particularly suited for use in locomotive erecting shops. A number of them are in use in the Union Pacific shops.

The device consists simply of a rectangular wooden box mounted on a standard or frame made of 1-inch pipe. There are ten small rectangular holes cut in the box, four on each side and one on each end, and behind each hole is placed a Bryant No. 280 receptacle. All of the ten receptacles are connected in multiple. A piece of two-conductor reinforced cord with a plug at either end completes the outfit.



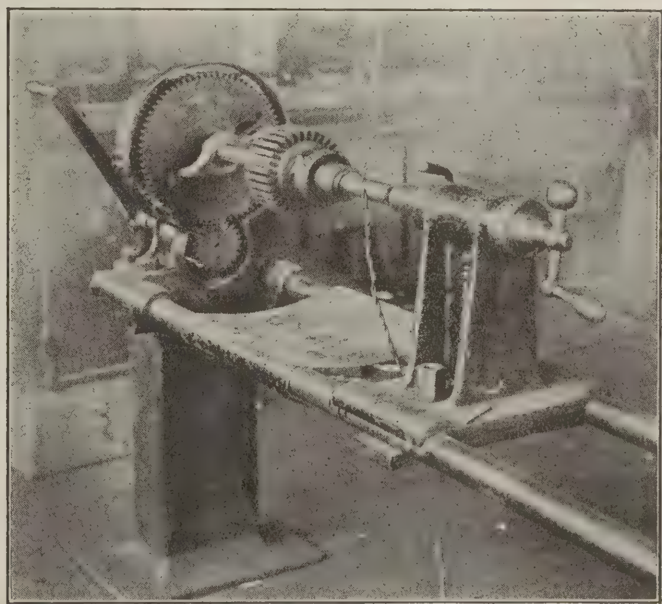
Multiple Extension Outlet Which Will Serve Nine Portable Extensions

At times there are six or eight men at work on a locomotive each of which wants to use a portable extension light. It is not practicable to have that many extension outlets at each locomotive location and where all of the outlets are at an end of the locomotive on a column or post it is necessary to have long extension cords.

When the multiple extension outlet is used, it is placed alongside the locomotive near the center and the cord with a plug on either end is used to connect it to the nearest outlet. Individual extension cords are then plugged into any one of the remaining holes in the box. In this way one permanent outlet can be used to serve nine lights. The individual extension cords can be made shorter and they are accordingly easier to handle and less subject to damage.

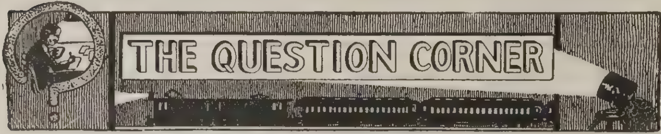
Armature Winding Machine

The machine shown in the illustration is similar in many respects to an engine lathe and is used for winding motor armatures. For winding, the armature is supported between two centers so that it is free to turn. When the coils are all in place, the dog shown at the left is clamped to the armature shaft and the crank is used to turn the armature while the banding wire is put on. The ratio of the gears is 3 to 1. Tension for the banding wire is provided by run-



Machine Used for Winding and Banding Armatures

ning the banding wire between two fibre blocks bolted together. The weight method is also used and this will be described in a later issue. The sliding tray under the armature provides a place for armature coils and tools. The cord suspended in front of the armature is fitted with terminals for testing and is connected to the lighting circuit in series with a lamp. The entire outfit was built, including the castings, in the Omaha shops of the Union Pacific.

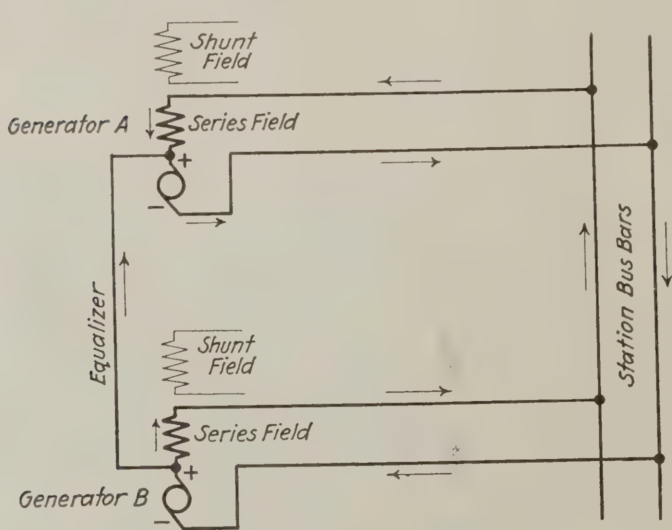


Answers to Questions

1. If two compound wound generators are connected in parallel on a switch board with an equalizer between them and the steam on one driving unit be shut down while its generator switch is still in, would this generator when run as a motor, run in the same direction or the reverse?—F. W.

2. What conditions would have to exist to cause the shunt field fuse of an axle generator to blow on account of a sticking dash pot?—R. A.

3. I am keeping in repair quite a number of steam turbines of the Pyle national type which are used on a steam pressure from 125 lb. to 200 lb. at 3600 R. P. M. For testing I have available only 75 lb. to 85 lb. air pressure. I should like to know of what speed I must set the governor with 85 lb. air pressure to obtain the speed of 3600 R. P. M. when the turbines are returned to the locomotives and are operated on 125 to 200 lb. steam pressure?—W. L. G.



Wiring Diagram Showing Connections and Current Flow

Compound Wound Generators in Parallel

1. Referring to the diagram the following changes in the circuit conditions may be traced out. As soon as the voltage of generator *A* falls below that of generator *B*, due to the steam being shut off at *A* and its speed reduced, current will flow through the system as indicated by the arrows. In other words generator *B* will run generator *nating current?*. A. L. B.

as a generator. The current through the armature of *A* will be reversed and this fact might lead some to think that the direction of rotation of *A* would be reversed.

When machine *A* runs as a generator its armature coils are whirling through its magnetic field and a voltage is generated in these coils. If current is taken from generator *A*, this current flowing through the coils of the armature will create magnetic lines around the coils of wire in the armature and the direction of these lines will be such that the repulsion between the magnetism of the generator field and the magnetic lines around each of the armature coils opposes the rotation of the armature, it takes force to overcome this magnetic repulsion.

When the steam is shut off machine *A* and its voltage falls below that of *B* it is driven as a motor and the current through the armature coils reverses. There is the same kind of repulsion between the field magnetism around each of the armature coils as when operating as a generator, but since the current through the armature coils is reversed this repulsion will be in the opposite direction from what it was. It will, therefore, drive the armature in the same direction instead of opposing its rotation.

When the Field Fuse Blows

2. Where the dash pot of a field generator sticks it will prevent field resistance being inserted on high speeds; it is absolutely necessary that this field resistance be increased on high speeds in order to keep the generator voltage down to normal value. Where this is prevented by the sticking dash pot, the generator voltage will rise as the train speed increases, and as the generator voltage rises the field current will also increase, causing a still further increase in voltage. As the train speed goes higher and higher a point will soon be reached where the field current rises above the capacity of the field fuse, causing it to blow.

Testing Headlight Turbines With Compressed Air

3. It is rather difficult to secure satisfactory results by testing in the mannner you have described. However, if you will first adjust the governor valve flush with the top of the valve cage and then adjust the governor so as to produce 31 volts at the binding posts no load, the K-2 and E-2 machines should produce approximately 32 volts operating at full load and variable steam pressures ranging between 125 and 200 lb.

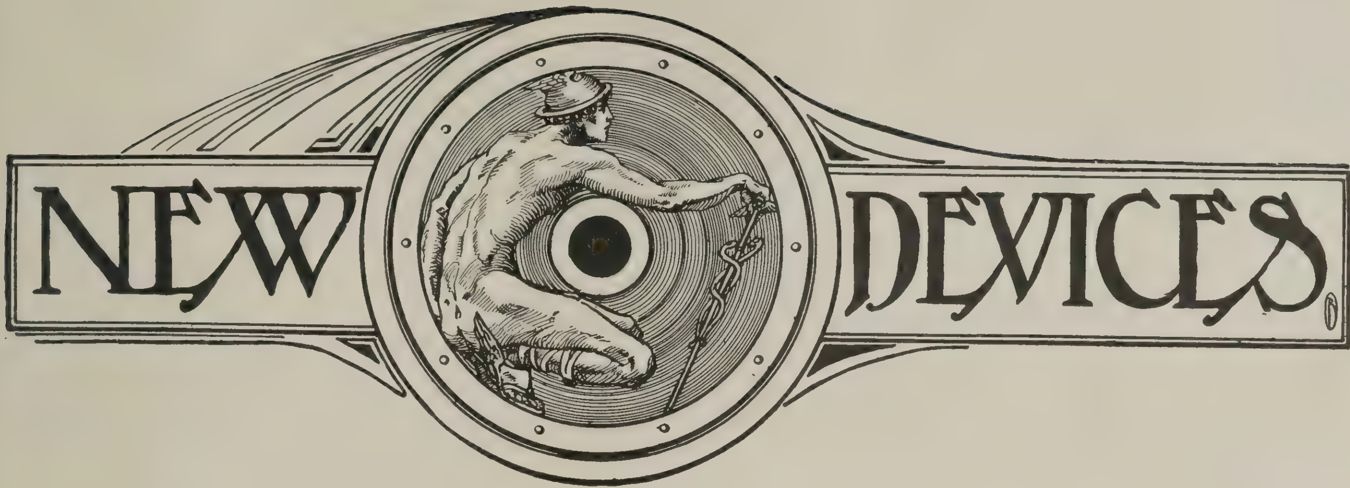
The use of a voltmeter is advocated for the proper adjustment of the governor because it is impractical to depend upon an arbitrary speed regulation on account of the gap and flux variations.

Questions for December

1. If a circuit contains a neglible resistance and has an inductance of .4 henry, what voltage is necessary to cause 5 amperes to flow? The frequency is 60 cycles per second.

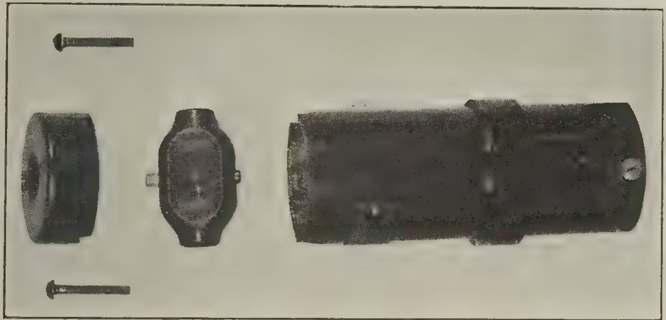
2. If an alternating current flowing through a resistance reaches a maximum value of 300 amperes during every alternation, what value of continuous current will develop the same amount of heat when sent through the same resistance?

3. What is this value called with reference to the alternating current?—A. L. B.

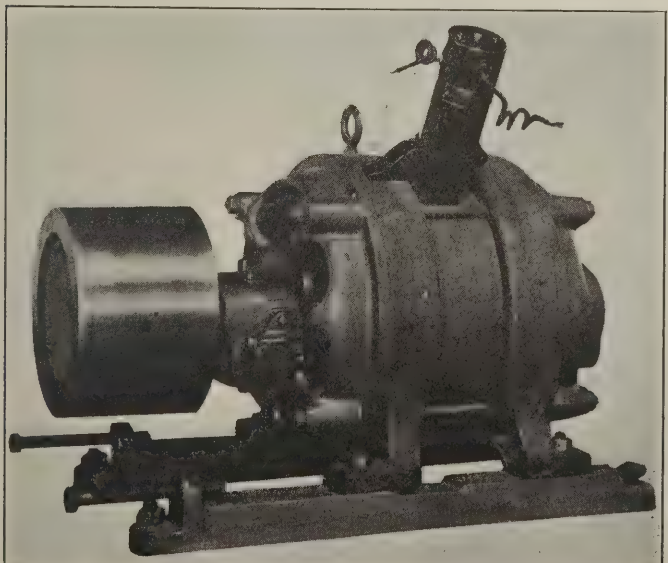


Thermal Relay

A thermal relay, designed to be applied to any surface from the temperature of which it may be desired to operate the relay, has been developed by the Automatic Reclosing Circuit Breaker Company, Columbus, Ohio. The lower end of the relay has a brass bulb projecting about ¼ inch beyond the bottom of the relay housing, which, when the relay is mounted in place, makes contact with the surface whose temperature is to effect the operation of the relay. When the temperature of this surface exceeds the temperature at which the relay is rated, an element within the relay housing expands and operates a push-button switch at the upper end of the relay. After the relay has operated the switch is reset by depressing the button which projects through the top of the housing. The switch is so mounted in the housing that the expansion may be used either to open the switch or to close it, depending upon how the switch is placed in the housing. The device is most commonly used for opening the circuit and is assembled with the switch in this position. If it is desired to use it as a circuit-closing relay, the cap of the housing is removed and the pushbutton switch rotated through 180 deg. The relay is used on control circuits not exceeding six amperes at 125 volts or two amperes at 250 volts.



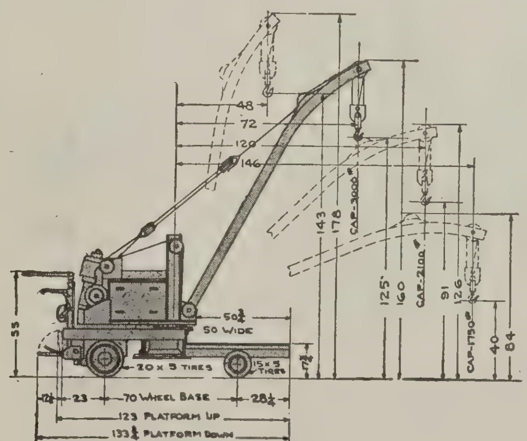
Exploded View of Thermal Relay Showing Cap and Switch



Induction Motor With Thermal Relay Applied to Armature Laminations

Crane Truck with Power-Swiveling Attachment

Unusual interest attaches to the new three-way crane truck made by the Baker R. & L. Company, Cleveland, Ohio, owing to the power swiveling attachment. This feature greatly increases the utility of the machine and enables the driver to operate it with far less exertion and accomplish more work in a given time. Another feature of importance is the double drum hoist. This hoist is driven by a single motor, the power being applied to either



Proportions and Lifting Capacity of Baker 3-Way Crane

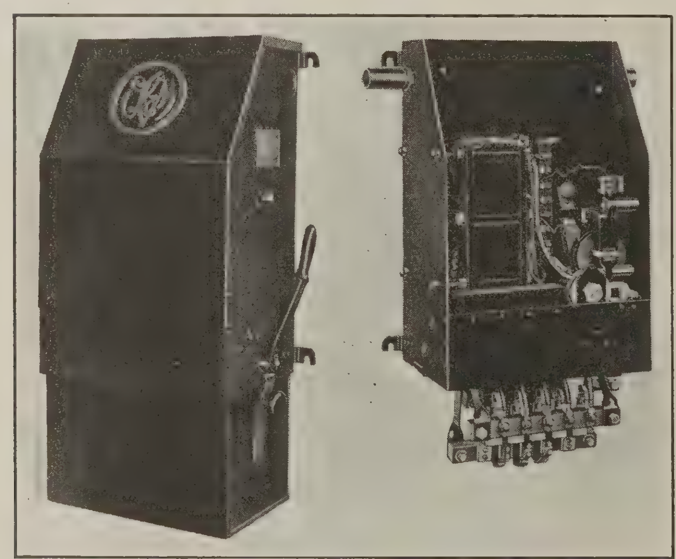
drum by means of magnetically operated friction clutches. This makes the change from one drum to the other very smooth, and the construction is such that the drum which is not working is firmly held by a large-sized brake.

On the Baker three-way crane truck illustrated two-wheel drive and four-wheel steer is provided, the capacity being as indicated in the illustration. The traveling speed without load is 530 ft. per min. or 6 miles per hour and with a rated load of 3,000 lb., 395 ft. per min. or 4½ miles per hour. The new load hoisting speed is 30 ft. per min. and with a rated load of 3,000 lb. the hook rises 7 ft. per min. Three speeds forward and reverse are obtainable by means of the controller which is of the continuous tongue drum type, totally enclosed.

The slewing unit is pillar mounted and turns on ball bearings. A worm and spur gear, reduction unit, transmits power from the slewing motor, provided with a magnetic brake. The slewing motor is compound wound, totally enclosed, operating at 24 volts and 32 amperes with a speed of 1,700 r.p.m. It has a high overload capacity. Control of the slewing motor is by means of a drum-type reversing controller mounted on the dash. Limit switches are provided, positive in action and automatically controlling the hoisting and reverse motions of the boom, hoisting motion of the load hoist and slewing motion. The boom is fabricated from structural steel and can be made to any length required within reasonable limits.

Hand Operated Compensator With Automatic Accelerating Device

A compensator for starting squirrel-cage induction motors which has the general appearance of a regular hand operated starter, but which is so designed that the starter is thrown into the running position automatically, was placed on the market on September 1 by the Electric Controller & Manufacturing Company, Cleveland, Ohio. The device is known as the Type ZK Manual Automatic Compensator.



E. C. & M. Manual Automatic Compensator, Complete and With Cover and Oil Tank Removed

To start the motor the operator throws the handle to the starting position and then leaves it alone. By throwing this handle the motor is connected through the transformers in the compensator to the line, and after the motor has accelerated to a speed where it can be safely thrown across the line, a relay operates a mechanism in the compensator which automatically throws the compensator from the starting position to the running position.

Mounted at the top of the compensator there is a panel with inverse time limit overload protection obtained by means of an expansion wire overload device. No-voltage protection is also supplied so that in case of overload or failure of voltage it is necessary to go back to the compensator and throw the handle to again start the motor. The characteristics claimed for the compensator are that it automatically accelerates the motor without danger to the motor or to the driven machinery, and that it protects the motor from damage which might be caused by overload, voltage or single phasing.

Electric Soldering Pot with Automatic Heat Control

A new electric solder pot with automatic heat control has been added to the line of labor saving devices manufactured by J. D. Wallace & Co., Chicago. It simplifies the problem of heating babbitt, white metal, wax and other materials which are slow conductors of heat. When metal is overheated it oxidizes, and this action results in a considerable loss of material and tensile strength. This pot is designed to overcome this oxidation. When solder has been heated to 600° F. an automatic control goes into action. The control maintains the temperature of the pot and prevents overheating and underheating.

This control is an adaptation of the principle used in the steam gauge. A volatile substance, which is very sensitive to heat, actuates a Bourden tube which makes and breaks the electric current, thus controlling the temperature of the contents of the pot.

Showing the Solder Pot with Automatic Control

The pot will accommodate fifteen pounds of solder and will heat this amount to 600° F. in twenty to twenty-five minutes. A 900 watt heating element is built around the entire container, heat being applied to all parts of the sides and bottom of the container simultaneously, thus coming in contact with the solder at all points, and reducing it to a working consistency.

The pot weighs only thirteen pounds, can be easily carried anywhere, and operates on either 110-V. or 220-V. alternating or direct current.

General News Section

The Western Electric Company has leased for a term of years the manufacturing plant of the Continental Candy Company in Jersey City, N. J. There are four buildings comprising 240,000 square feet. About 1,500 employees will be engaged in the manufacture of telephone switch boards.

The Pawling & Harnischfeger Company of Milwaukee, Wisconsin, manufacturers of excavators, cranes and machine tools, have recently appointed R. P. McCormick as their eastern sales manager with headquarters at 50 Church street, New York City, and 605 Stephen Girard Bldg., Philadelphia.

The Bridgeport Brass Company announces the appointment of E. E. Helm as district manager at Detroit. Mr. Helm comes from Akron, Ohio, where for two years he was manager of the Industrial Bureau of the Akron Chamber of Commerce, being particularly interested in diversifying the industries of the Rubber City.

Contract for the battery charging plant in connection with the new $3,000,000 terminal of the Philadelphia & Reading Railway's seashore lines at Camden has been awarded by the company to W. V. Pangborne and Co. This installation consists of motor generator set, charging panels and the necessary wiring in connection therewith. It will be used for changing passenger car batteries and tractor batteries.

The Pennsylvania Railroad has recently equipped the Shamokin roundhouse on its Sunbury Division with electric coal and ash hoists. All yard and mine locomotives working in the anthracite region are coaled at this point and the lack of modern devices has been a drawback for a number of years. The hoists were installed by the Ogle Construction Company of Chicago, assisted by the railroad company's forces.

The Standard Underground Cable Company announces the following changes recently made in its Perth Amboy, N. J. organization: H. W. Fisher has been advanced in title to technical director of electrical engineering, while continuing also as manager of lead cable and rubber departments. R. W. Atkinson has been appointed chief electrical engineer, and G. J. Shurts has been made production manager of lead cable department.

The Electric Heating Apparatus Company, manufacturers of "Multiple Unit" and "Heavy Duty" electric furnaces, general offices and works at Newark, N. J., has recently terminated an agreement with the Westinghouse Electric & Manufacturing Company for the exclusive sale of their special furnaces. The Electric Heating Apparatus Company has enlarged its sales and service department and has established a district office in Chicago. F. A. Hansen, formerly in charge of sales of electric furnaces in the Chicago territory for the Westinghouse Electric & Manufacturing Company, has been appointed district manager for the Electric Heating Apparatus Company in the Chicago territory with office in the Marquette Building, Chicago.

Important organization changes announced by the Western Electric Company involve the appointment of three new assistant works managers and two superintendents in the manufacturing department. C. L. Rice, formerly production superintendent of the Hawthorne Works at Chicago, and S. S. Holmes, general superintendent of installation of the installation department, have been promoted to assistant works managers at Hawthorne. R. C. Dodd, at present operating superintendent of the Hawthorne Works at Chicago, has been promoted to assistant works manager at the new Kearny, N. J., Works. This appointment is effective March 1, 1924.

J. J. McKenna, formerly assistant general purchasing agent at Hawthorne, succeeds Mr. Rice as superintendent of Production and W. H. Meese, supervisor of installation methods and results, succeeds Mr. Dodd as operating superintendent at Hawthorne.

Motor Trains Increasing in France

The use of internal-combustion motors for trains appears to be developing rapidly in France. The State Railway, it is announced, has recently placed an order for 10 units on the model of the one tried out successfully between Mortagne and St. Gauberge, the motor being applied to an ordinary passenger coach. The Renault firm is also actively engaged in perfecting a new type of motor train called the Scemia-Renault, which was run on trial recently over the lines of a local Rheims company. This car carries 40 passengers and is equipped with double-end controls, whereby the necessity of a turntable is avoided. On the 350-mile stretch between Rheims and Asfled, with 2.5 to 2.8 per cent grades, the average gasoline consumption was 108 gallons per 1,000 miles and the average speed 25 miles per hour. With a trailer, the consumption would be 138 gallons. It is stated that orders for six cars have been received and that the Societe des Transports en Commun de la Région Parisienne, which controls all the surface traffic in and around Paris, intends to place one of them in regular service on the Versailles-Les Mureaux line.

Rock Island Stock for Employees

The Chicago, Rock Island & Pacific has put into effect a plan whereby employees may secure preferred stock on a monthly payment basis. Any employee of the company of more than six months' service may invest in the preferred stock of the railway under this plan. Both 7 per cent and 6 per cent preferred stock may be bought but the total which may be ordered or carried at any one

time must not exceed one share for each $300 of annual salary or pension of the employee and shall not exceed ten shares altogether.

The amount to be paid for the stock will be governed by the market price at the time it is purchased. Active employees of six months' service or more will be required to make an initial payment of $5 a share and a monthly payment thereafter of not less than $3 a share. Pensioned employees are permitted to buy, and they are not required to make the initial payment of $5 a share. Ten per cent of the purchase price will be deducted from each monthly pension check.

The company will hold the stock purchased as security for the payments of the balance of the purchase price, which balance will be paid through payroll deductions as authorized by the employee. Interest at the rate of six per cent per annum will be assessed on the unpaid balance, and dividends received on the stock will be applied to the unpaid balance. The employee may make full payment at any time but contracts of purchase are not transferable. An employee may terminate the contract at any time, when the stock will be sold at the current market price.

General Electric Co. Combines Departments

The publication and advertising departments of the General Electric Company were combined on December 1 with Martin P. Rice, as manager of the publicity department, in charge.

Frank H. Gale, advertising manager, becomes assistant to D. R. Bullen and manager of conventions and exhibits. Mr. Bullen was recently appointed assistant vice-president and Mr. Gale will do important association work.

C. H. Lang, who has been assistant to Mr. Rice as manager of the publication department, will continue as assistant manager of the newly created publicity department and T. J. McManis who has been manager of the department of publicity for the Edison Lamp Works of the General Electric Company at Harrison, N. J. will also become an assistant manager of the new department.

In addition to the above announcement made by president Gerard Swope, an advertising council has been created, effective December 1st, with the following members and with director B. G. Tremaine, vice-presidents J. R. Lovejoy, George F. Morrison and F. S. Terry and A. D. Page as ex-officio members of this council:

Chairman of the council, J. G. Barry; manager of the publicity department, M. P. Rice; assistant manager of the publicity department, T. J. McManis, P. B. Zimmerman, George C. Osborne, L. P. Sawyer, G. P. Baldwin; advertising counsel, Bruce Barton; secretary of the council, C. H. Lang.

C. & E. I. Complies with Train Control Order

The Chicago & Eastern Illinois has given an order to the Miller Train Control Corporation to install the Miller automatic train stop device on its road engines, not now equipped, which run on or over the territory between Dolton, Ill., and Danville, designated in the Interstate Commerce Commission's train control order. At present, 98 engines are equipped and approximately 10 engines remain to be equipped. This road has also authorized the Miller Train Control Corporation to change the present train control engine equipment to comply with the requirements of the Interstate Commerce Commission's train control order. These alterations do not affect the fundamental principles of the device or its functioning to a stop, but eliminate the permissive feature by preventing the engineman from forestalling a brake application or releasing the brakes after receiving an application before the train comes to a stop.

Westinghouse-Japanese Arrangement

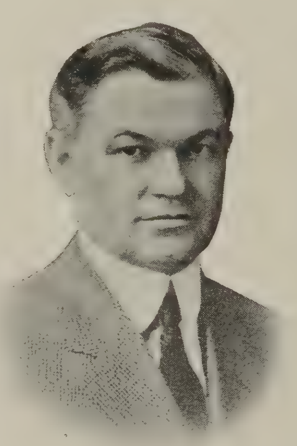
A new company known as the Mitsubishi Electric Manufacturing Company has been formed with a reported capitalization of $7,500,000.

In recent years electrical apparatus has become one of Japan's largest imports, and since Japan's principal exports consisting of silk, copper, and objects of art, cannot be expanded by a corresponding degree, it has been deemed wise by the Japanese to begin the manufacture of electrical machinery and supplies to obviate a possibly unfavorable balance of trade. The company consists of a Japanese manufacturing company which will be supplied with technical skill and experience by the Westinghouse Company.

A third party to this agreement is Takata & Co., 30 Church street, New York City. This concern which is the Japanese agency of the Westinghouse Company will act as distributor for the Mitsubishi Electric Manufacturing Company and will also continue to import such Westinghouse products as will be supplied from America.

Personals

Ernest Lunn, electrical engineer of the Pullman Company, was elected president of the Association of Railway Electrical Engineers at the fourteenth annual convention of the association which was held in the LaSalle Hotel, Chicago, November 6 to 9. Mr. Lunn was born in Greenville, Mich., in 1874. He graduated from the University of Michigan in 1899 as electrical engineer and was then employed for three years by the Detroit Edison Company. In 1902 he associated himself with the Commonwealth Edison Company as storage battery engineer and served in this position for 12 years, with the exception of a seven months' period in 1910, when he was in the service of the Firestone Tire & Rubber Co. of Akron, Ohio. For a period of time Mr. Lunn acted as consulting engineer for the Walker Vehicle Company of Chicago, and from 1903 to 1914 he was successively secretary-treasurer, vice-president and general manager and president of that company. In 1914 he accepted the position of chief electrician of the Pullman Company. Mr. Lunn



Ernest Lunn

was elected a manager of the American Institute of Electrical Engineers in 1922.

J. C. McElree, formerly electrical engineer of the Central of Georgia has accepted a position as electrical engineer in the mechanical department of the Missouri Pacific, with headquarters at St. Louis, Mo.

J. C. McElree

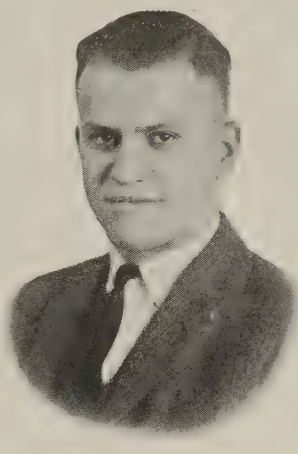
He was born in Republic County, Kansas, on May 15, 1878, and educated at the public schools of Valparaiso, Ind. Mr. McElree's first experience in railroad work was with the Pullman Company, at Pullman, Ill. Later he worked for the Southside elevated road at Chicago for about three years. Subsequently, he spent three years with various electrical contractors in Chicago. In 1904, he entered the service of the Illinois Central as an electrician at the Burnside shops. He was promoted to assistant foreman in 1908 and two years later was made foreman in charge. He was again promoted to assistant chief electrician in 1917, and in 1919 he accepted a position as electrical engineer for the Central of Georgia, which position he held until his recent appointment with the Missouri Pacific.

R. L. McLellan, assistant to F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Company, was elected president of the Railway Electrical Supply Manufacturers Association at the annual meeting of that association held at the La Salle Hotel, Chicago, Ill., on November 9.

R. L. McLellan

Mr. McLellan was born in Valparaiso, Ind., in 1886. He graduated with a degree of electrical engineer from Purdue University in 1907. After leaving school, he was engaged in designing transformers for a period of about a year for the Lafayette Manufacturing Company, Lafayette, Ind., and for two years he was employed by the Fairbanks Morse Electric Manufacturing Company, Indianapolis, Ind., where he served in various capacities in engineering work. In 1910, he was appointed manager of the sales department, Merchants Heat & Light Company, Indianapolis, Ind., and after a year in this service was engaged for three years by H. M. Byllesby & Co., Chicago, Ill., in central station management. In 1914, he was made sales manager for the Appalachian Power Company, Bluefield, W. Va., and in 1915, took up work with the railway sales department of the Westinghouse Electric & Manufacturing Company, Chicago, Ill., where he was in charge of steam railway sales in the Chicago territory. In 1921, Mr. McLellan was made assistant to F. H. Shepard, director of heavy traction and in this capacity he has represented the Westinghouse Company in electrification negotiations in Chile, Brazil, and European countries, having returned from Europe late in November this year.

Owen L. Howland has become associated with the Transportation Engineering Corporation, Chicago, Illinois; in which position he will be connected with the sale of welding supplies.



Owen L. Howland

Mr. Howland was born August 8, 1892, in Kansas City, Mo., and received his grade and high school education at Hillside, Wis. He attended the University of Wisconsin at Madison, specializing in Mining Engineering. He began his professional career with the Copper Queen Mining Company at Santa Barbara, Mexico, and was later transferred to Bisbee, Arizona. In 1915, Mr. Howland entered the service of the El Paso & Southwestern Railroad Co., at El Paso, Tex., as a boilermaker apprentice, and shortly afterward took up electric welding as applied to the maintenance of railroad equipment. A year later he went with the Baltimore & Ohio Railroad Co. During the next few years, he had a varied experience as an electric welding operator with the Sun Shipbuilding Co., the Bethlehem Shipbuilding Co., the Siemund & Wenzel Co., the Newburgh Shipbuilding Co., the New Port News Shipbuilding & Dry Dock Co., the Cambria Steel Co., The Fabricated Steel Tank Co., and the Standard Oil Co. of Wyoming. In March, 1921, he entered the sales department of the Central Steel & Wire Company of Chicago, specializing in the sale of welding wire and rods, where he remained until he accepted his present position.

R. S. Gay, representative of the Safety Car Heating & Lighting Company, with headquarters at Chicago, has resigned from his position with that company.

Walter N. Ballou has been appointed manager of the transportation division of the Atlanta office of the Westinghouse Electric & Manufacturing Company and will have charge of the light and heavy traction business of the company in that territory.

Martin P. Rice recently appointed publicity manager of the General Electric Company has been in the employ of the company for 28 years. He was graduated from the University of Pennsylvania in the class of 1893 with the degree of bachelor of science, then took a post senior course, receiving the degree of mechanical engineer.

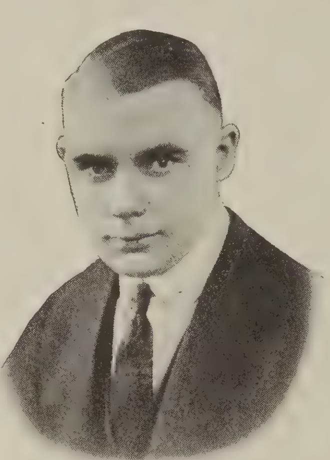
Mr. Rice entered the service of the General Electric Company in 1895 and was first employed in the drafting

room. After nine months he was transferred to the engineering department and when the X-ray was discovered, was assigned to that new work. The publication bureau was organized in December, 1897 and he was made manager, a position he has since held. In this position he had supervision of all company printing, photographs, technical data files, and all general publicity for the company. In June, 1903, he established the General Electric Review, first as an internal publication, but today considered one of the important technical magazines of the country.

In February, 1921, when the company became interested in radio broadcasting, Mr. Rice was made director of radio broadcasting and in this position outlined the company's policy in this new field. He readily recognized that broadcasting should be more than a mere entertainment to be successful, and that its programs should be educational and helpful to the public in the distribution of interesting events of the day.

The company is now building a second large radio broadcast station in Oakland, California, and has definitely announced plans for a third station to be built at Denver, Colorado, both of which will come under Mr. Rice's supervision.

Fred A. Hansen, was appointed district manager for the Electric Heating Apparatus Company in the Chicago territory effective with the recent termination of a sales agreement of this company with the Westinghouse Elec. & Mfg. Company. Mr. Hansen attended the Northwestern University, Chicago and the University of North Dakota and first entered railway service in 1913 on the Atchison, Topeka & Santa Fe in the track department. In 1914, he left the Santa Fe to enter the signal department of the Chicago, Rock Island & Pacific and later served the American Bell Telephone Company until he entered the army during the late war. Mr. Hansen served about a year in France in the engineering corps of the army and after the Armistice was signed he had charge of the electrical construction work at the Savenay Base Hospital center in France. Upon his return to the United States he entered the employ of the Westinghouse Elec. & Mfg. Company as industrial heating engineer handling electric furnaces, and other industrial electrical heating propostions. On September 1, 1923, the sales agreement between the Electric Heating Apparatus Company, Newark, N. J., and the Westinghouse Electric & Mfg. Company was terminated and in expanding the sales and service department of the Electric Heating Apparatus Company Mr. Hansen was appointed district manager with headquarters in Chicago.



Fred A. Hansen

H. L. Unland, for thirteen years engineer with the General Electric Company, eleven years of which were spent in the power and mining department, leaves that concern December 1st, to take the position of electrical engineer with the Victor Talking Machine Company at Camden, N. J.

Mr. Unland is a graduate of the Engineering College of the University of Nebraska, class of 1910. He was born in Lincoln, Nebraska, in 1887. Following college he entered the General Electric test. He was in charge of the water rate test and later became connected with the power and mining engineering department on power and transmission station applications. Later he specialized in electric welding and is the author of many articles on this subject. He is an associate member of the A. I. E. E. and was active in organizing the northern New York section of the American Welding Society. During the war he was engaged in the ordnance department of the army on arc welding work.

Trade Publications

Wagner Electric Corporation, St. Louis, Mo., has recently issued an illustrated folder showing one of the small and one of the large types of transformers which it manufactures.

The Ohio Brass Company, Mansfield, Ohio, recently issued a one-page folder illustrating a number of O-B splicers for emergency and maintenance work in connection with trolley construction.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is distributing a 16-page illustrated bulletin, showing the new model design of the Westinghouse underfeed stoker. Many photographs are shown illustrating the various parts of the equipment.

Electric Service Supplies Company, Philadelphia, Pa., recently issued a publication known as report No. 367 which describes in detail and gives engineering data regarding the installation of floodlighting lamps on the Norfolk & Western Railway. Light distribution graphs are shown as well as typical yard layouts indicating the position of the lighting units. One important feature of the report is the cost analysis which gives some very interesting information concerning the cost of installation and maintenance of this kind of equipment. Three large original photographs, showing night views of the yard, are included in the report.

Pyle-O-Lyte is the name given to the latest bulletin issued by the Pyle National Company, Chicago. The bulletin which is also known as catalogue No. 4 contains 28 pages, illustrating and describing the applications of Pyle National equipment to the various phases of railroad and construction lighting. There are many photographs and diagrams showing the different types of lighting units, together with the specifications for each. Lamps and reflectors are shown giving descriptive and dimensional tables. A portion of the bulletin is devoted to the explanation of floodlighting calculations which is clearly set forth by diagrams and sample calculations fully worked out. The different types of Pyle National turbo generators are illustrated ranging in capacity from 500 watts to 7½ kw., and steam turbines for various purposes ranging in speed from 2,000 to 5,000 r. p. m. and from ½ hp. to 12½ hp. are also shown.

Power | Illumination

Railway Electrical Engineer

Heavy Electric Traction | Train Lighting | Electric Welding

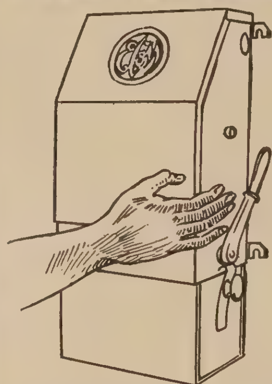
VOLUME 14 | DECEMBER, 1923 | NUMBER 12

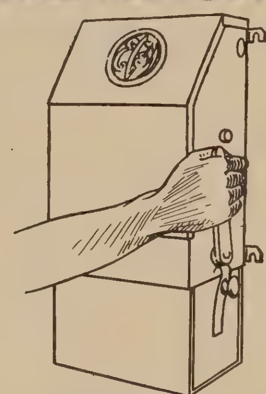
The G-E Headlight Turbine

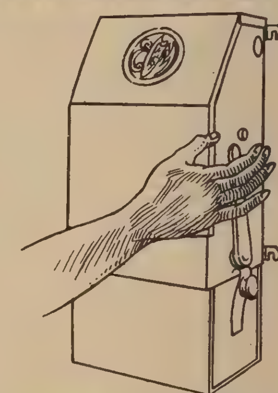
General Electric Company
Schenectady, N. Y.

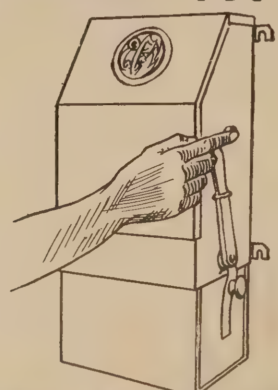
25-235

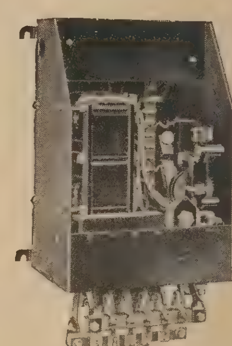
GENERAL ELECTRIC











Volume 14 Number 12

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The Railway Electrical Engineer is a member of The A B P Inc.


STEPS of PROGRESS
REG.U.S.PAT.OFF.
We might remark as a pun: — "the sole idea of this picture is to make an impression."
However, serious thinking railroad men will confidently expect our fourth important step in car lighting development to produce economies in operation equal in importance to the accomplished economies of the other steps.
PUTNAM BATTERY LONGER LIFE WITH LESS LEAD
UNDER-FRAME SUSPENSION LESS WEIGHT BETTER DISTRIBUTED
SAFETY SHADE-HOLDER CUSHION GRIP SAVING REFLECTORS
THE PINTSCH MANTLE MORE LIGHT LESS GAS
THE SAFETY CAR HEATING & LIGHTING CO.
NEW YORK CHICAGO ST. LOUIS BOSTON
PHILADELPHIA SAN FRANCISCO MONTREAL

Railway Electrical Engineer

Vol. 14 December, 1923 No. 12

Platforms and Shelters Nearing Completion at P. & R.'s Camden, N. J., New Terminal

Contents

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REQUEST for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your OLD address as well as the NEW one.

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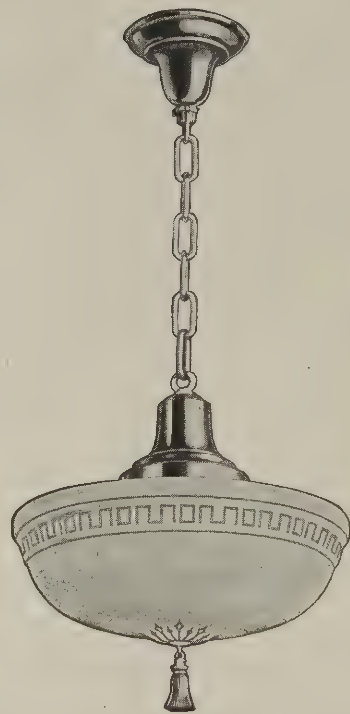
ATTALITE USERS ARE NOW WRITING OUR ADS—

ATTALITE
"ATTA BOY!—ATTA LITE!"

CHICAGO TEMPLE BUILDING
Clark and Washington Sts., Chicago,
Holabird & Roche, *Architects.*

This magnificent structure completed in 1923 combines the Methodist Church with a well-appointed office building.

Attalites were selected for the lighting after competitive tests with twenty manufacturers. The No. 6512, shown on page 13, was used.



Attalite Pendant Luminaire
Utility Type

Standard finish statuary bronze. Special finishes at small additional charge. The globe is decorated in a sepia or dark brown tone, and harmonizes best with a statuary bronze hanger. Decoration is burned into glass and is permanent.

CHICAGO, BURLINGTON AND QUINCY RAILROAD
OFFICE BUILDING
547 W. Jackson Blvd., Chicago
MARSHALL & FOX, *Architects.*

Attalites were chosen, after a careful test because they showed greater light on the working plane and less waste on the walls. The No. 6614 in statuary bronze was chosen.

Central Electric Co., Chicago.

Gentlemen:—I am convinced that all you said of the Attalite unit is true, and the comparative reading of the foot candle meters show that I am getting much more light and better distribution.

Yours truly,
S. J. Stone & Co., Beloit, Wis.

2700 ATTALITES

were installed in these two well-known buildings

because—

the architects and owners of these buildings recognized that good lighting was not only essential but that

The Attalite is a Better Light

and *insisted* upon it

About the Attalite

We've always thought the Packard automobile slogan, "Ask the man who owns one," to be a mighty good one. When you can rest your case on the users of your product and be sure of a most favorable verdict, you've sure "got the goods."

You ought to hear what the users of the Attalite say about it. If these big users did not find that the Attalite was bringing them better working conditions, better service and better light, you can bet your bottom dollar that we wouldn't be getting such testimonials.

Railroad executives everywhere are beginning to more and more appreciate the value of having better lighting in their offices. The Attalite provides an easy way of securing it. Attalite will improve the appearance of your office and add a pleasing finishing touch.

The picture of the Attalite shown here can't begin to do it justice. If you will write us, we will promptly mail you a copy of our new Attalite catalog No. 95-RE listing the complete Attalite styles and finishes. Address "Lighting Division."

Central Electric Company
FOUNDED 1887
The House of Service
316-326 South Wells Street
CHICAGO

ORGNIZ IT NEVER DISAPPOINTS
DISTRIBUTING GE JOBBER

BATTERY CHARGING RECEPTACLE

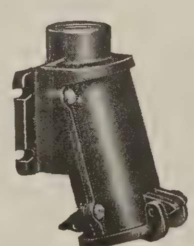
100 AMP. 250 VOLT, 2 WIRE
200 AMP. 250 VOLT, 2 WIRE

Type C. R. C.
Receptacle

Type S. P. Plug with
strain relief bushing

PLUGS AND RECEPTACLES

100 AMP. 250 VOLT, 2 WIRE
200 AMP. 250 VOLT, 2 WIRE



Type C. R. B. B.
Receptacle

Type S. P. Plug with
strain relief bushing

OLIVER ELECTRIC AND MANUFACTURING CO.
SAINT LOUIS, U. S. A.

Western Electric Company
DISTRIBUTORS

This jar will not leak profits

The "Giant" Rubber Jar of an Exide Battery frees you from the never-ending expense and trouble of repairing lead linings.

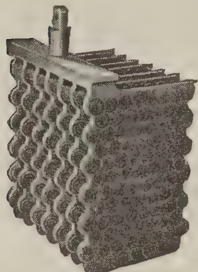
LEAD linings are no longer a necessary evil in car-lighting cells. With Exide Batteries you can substitute rubber jars. Plates that do not buckle or grow make the use of these jars possible.

The Exide "Giant" Rubber Jar is stronger than any similar jar heretofore used. Breakages with it are negligible. It does not leak; it is not affected by acid or corroded by current. It provides thorough insulation, preventing short circuits or leakage of current. It effects a substantial saving in weight.

Strong—where a battery is most vulnerable

The most vital part of any battery—and also the most vulnerable as a rule—is its positive plate.

Not so with an Exide, however. The positive plate of this battery is one of its strongest features. No other type of plate on the market can approach the Manchester positive of the Exide in long life, ruggedness, durability, and ability to meet the exacting demands of railway service.



A Manchester positive plate group. The soft lead buttons constituting the active material are held within a rigid grid of cast lead-antimony alloy. Result—long life.

The Manchester Plate does not buckle or grow, because the frame is rigid—made of cast lead-antimony alloy, and the active material is not part of the frame. This frame has circular openings, into which are forced under pressure the rolled buttons of soft lead that are the active material. Any tendency toward growth of the buttons merely tightens them in the grid.

Long interval between cleanings

A further result of this construction of the positive plate is longer life of the active material, since there is less opportunity for it to become dislodged.

Testing the height of sediment in an Exide cell without removing cover. Exide Batteries require cleaning only once during their life.

Exide Batteries need be cleaned only at long intervals, usually not oftener than once every five years. This is because sediment is deposited slowly, and the sediment space in an Exide cell is extra-large.

The operating records of railroads using Exide Batteries show that the frequency, and therefore the cost, of sediment removal is less than half that of batteries having soft lead plates.

Cutting down yard handling

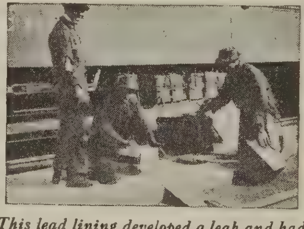
From one car-shopping to another, Exide Batteries remain in the battery box. It is hardly ever necessary to handle an Exide in the yards, for the ailments that make this handling necessary with other batteries are not found in Exides. They are rugged and well able to withstand the shock and vibration of railway service.

Separators are extremely long-lived. Jars provide ample free acid and sediment space. Jar troubles are almost unknown, thanks to the Exide "Giant" Rubber Jar. Exide plates do not buckle or grow, because the active material is not part of the frame, and this frame is rigid —made of cast lead-antimony alloy.

Keeping lights bright

There are two reasons why Exide Batteries result in better light: The variation in voltage between charge and discharge is small and there is no loss of voltage through the development of weak or dead cells. Consequently, there is the least possible variation in voltage, and unvarying voltage is the first essential of good lighting.

There are seventeen Exide branches covering the country, equipped to give you complete sales service or make prompt shipment of renewal parts from nearby stocks.



This lead lining developed a leak and had to be removed in the yards. Exide Batteries have rubber jars because the plates do not buckle or grow.

If you write us, a representative from our nearest branch will call with detailed facts and figures that you will find valuable.

Exide

BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

2 Sta He

Simmons-Boardman Pub. Co.
30 Church Street,
New York, N. Y.

Book Service Department

(Outside)

See other side for directions for mailing this card.

Have you read these books?

Railroad Electrification and the Electric Locomotive

by Arthur J. Manson

Electric Arc Welding

By E. Wanamaker and H. R. Pennington

Two volumes that are as indispensable to Electrical Engineers whose work lies in their respective fields as is "Car Lighting by Electricity" to Electrical Engineers who work with Cars.

Both are described in the *Electrical Engineer* for October. If you wish to examine either or both of the books, check the other side of this coupon and mail it *now*.

Car Lighting by Electricity

was written to answer these questions—and others:

How were the present systems of Car Lighting developed?

Chapter I deals with early attempts and the evolution of the systems in use today.

What are the various systems—their advantages—disadvantages?

Chapters II, III, and IV cover the Straight-Storage System, the Head-End System and the Axle-Generator System.

How is the Axle-Generator System regulated?

Chapter V tells you.

What about transmission?

Chapter VI covers this phase of the subject.

What are the various types of storage batteries? How are they connected—how maintained?

Chapters VII and VIII cover batteries.

What is the Ampere-Hour Meter and how is it applied?

Chapter IX tells you—and Chapter X tells you more.

What are the newest types of fixtures for various cars?

Chapter XI describes them.

What steps are necessary to install new car lighting equipment? To test and adjust it?

See Chapters XII and XIII respectively.

What practice is followed in service inspection and test?

Chapter XIV covers this, with descriptions of instruments and methods.

What are the best tools for use in handling car lighting equipment?

Chapter XV describes and illustrates tools that practical experience has found necessary.

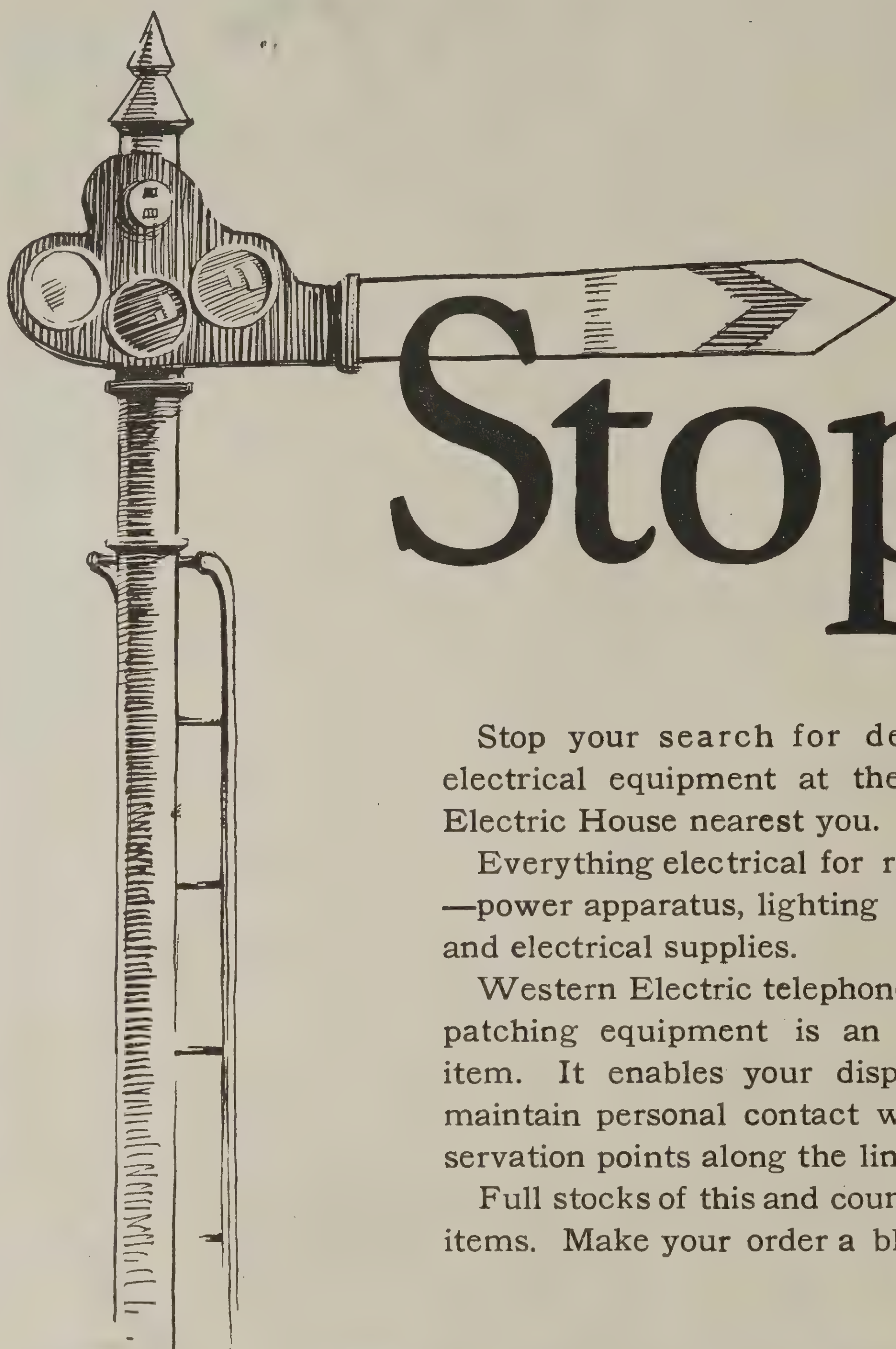
What are the characteristics of leading systems now in use?

E. S. B. Car Lighting Equipment, the Gould "Simplex" System, Safety Car Lighting Equipment, Stone-Franklin Equipment, U. S. L. Equipment and Direct-Drive Equipment for Axle Generators—all are covered in Chapters XVI to XXI.

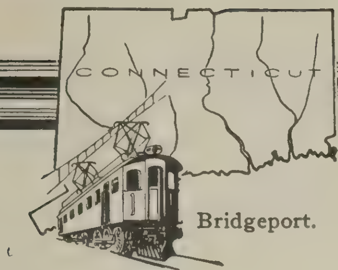
A. R. A. Standards and Recommended Practice

are included in an Appendix containing Specifications for Axle Generators; Electric Train-Lighting, Standard Practice—General, Generator, Batteries, Wiring, Electric Train-Lighting; Recommended Practice—General, Generator, Batteries, Wiring, Lamps, Axles.

See Mr. Stuart's book without expense—just mail the convenient card, *today*.



A helpful service to electrified railways is located at Bridgeport.



When Dewey's Guns thundered at Manila

STREET RAILWAY JOURNAL. [VOL. XIV. No. 6.

94

"Phono-Electric" Wire FOR TROLLEY, TELEPHONE and TELEGRAPH LINES

High Tensile Strength and Elastic Limit. Great Ductility. Will not stretch. Does not break at kinks, joints or scratches. Practically non-corrodible. This wire cannot be equalled where safe, durable and permanent construction is required.

THE BRIDGEPORT BRASS CO., ... BRIDGEPORT, CONN ...

19 MURRAY STREET, New York. 17 NORTH 7th STREET, Philadelphia, Pa. 85-87 PEARL STREET, Boston.

ESTABLISHED ...

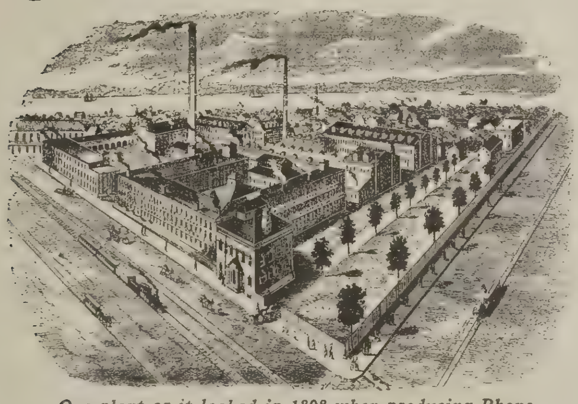
An Advertisement

—reproduced from the June 1898 Street Railway Journal

Phono-Electric

—a good wire then!

In Spanish War days, Phono-Electric was just in its infancy, in an industry which was itself quite young. Only ten years before that, the first practical trolley car installation had been made. But even in those early days progressive railway operators and electrical engineers were quick to grasp the economy-producing opportunity afforded by a trolley wire which would outlast the ordinary product three or four times.

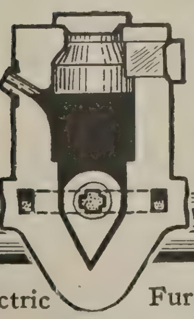


Our plant as it looked in 1898 when producing Phono-Electric as advertised.

—a better wire now!

A quarter of a century has passed! During that time experience with many installations has been translated into improvements in the manufacture of Phono-Electric. In other words a good product has been made better.

That old advertisement above tells in the minimum number of words the story of Phono-Electric's qualities. Those qualities are even more strongly emphasized in present day Phono-Electric.



Electric Furnace
Non - Ferrous Alloys.

Bridgeport Brass Company

BRIDGEPORT - CONNECTICUT

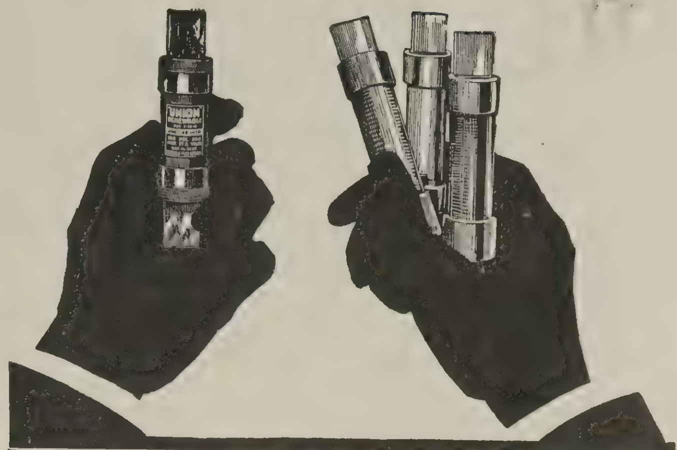
Pershing Square Building, - - - New York City
North American Building, - - Philadelphia, Pa.
Wrigley Building, - - - - Chicago, Illinois
General Motors Building, - - - Detroit, Michigan

"Bridgeport" BRASS CO. TRADE MARK

Phono-Electric

WE MAKE

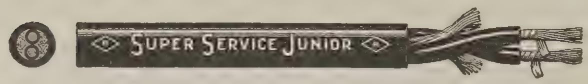
Ledrite Brass Rod
Phono-Electric Contact Wire
Plumrite Brass Pipe
Phono-Hi-Strength Wire
Tubular Plumbing Goods
Condenser Tubes - Sugar Tubes
Brass, Bronze and Copper Sheets
Brass, Bronze and Copper Tubes
Auto, Bicycle and Pressure Pumps
Auto Accessories - Stampings
Engravers' Copper - Specialties
Screw Machine Products
Pressed or Drawn Products
Oil and Grease Guns



"UNION"
RENEWABLE
UND. LAB INSP
600 AMP.
600 VOLTS
"UNION"
RENEWABLE
UND. LAB INSP

ROME WIRE

Super Service JUNIOR



Put this new wire to work!

It's the handiest wire you ever saw—strong as rawhide and so flexible you can tie knots in it, and as durable as it is attractive.

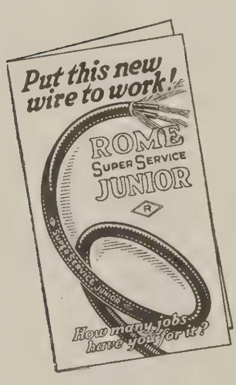
There is use for it everywhere in connection with mine telephones, lamps and signal systems; in barber shops for vibrators and hair dryers; on soda fountains for mixers and squeezers; in hospitals for a dozen devices; in homes for vacuum cleaners, sewing and washing machines; in shops for fans and light tools; in offices for business appliances; in radio; for dentists and jewelers, and so on down the list.

It gives real service in wet places, it is highly resistant to oil, grease and acid, it will stand up under constant battering and bending. How many jobs have you got for it?

Super Service Junior—No. 18—Two Conductor

Two conductors, each of forty-two number 34 B & S gauge bare copper wires, rope stranded for strength and flexibility, cotton wrapped, covered with 1/32-inch rubber 30 per cent insulation, twisted together with cotton cord fillers, then over all a heavy jacket of 60 per cent Super Service Rubber with an outside diameter of .295 inch, vulcanized S in steel moulds under tons of pressure. Tensile strength, 160 lbs. Approved, of course, by the Underwriters' Laboratories under Type SJ Cord. Put it to work—NOW!

Send for the Booklet J
and a Sample!



R

"Super Service"
Registered
U. S. Patent Office

ROME WIRE COMPANY

Mills and Executive Office
ROME, N. Y.

Atlantic Mills
STAMFORD, CONN.

"Diamond" Branch
BUFFALO, N. Y.

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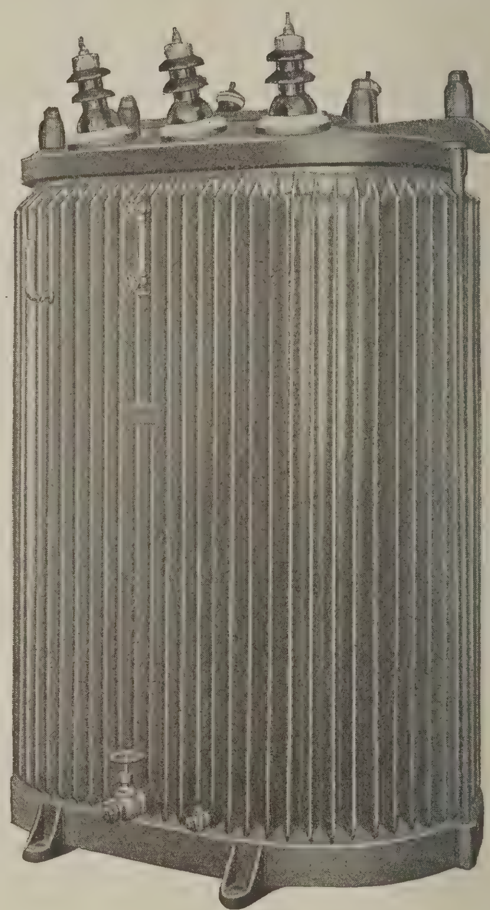
WIRE-ROME

KUHLMAN TRANSFORMERS



Since 1893

Approved by the Most Capable Engineers

Kuhlman Electric Company

BAY CITY MICHIGAN

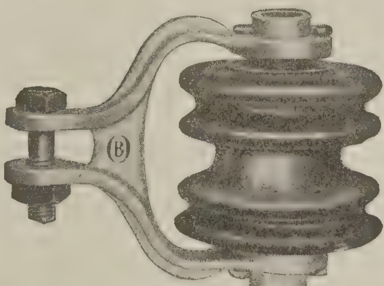
Agents in Principal Cities

Strain Insulators

Porcelain

Composition

Wood



Porcelain with Clevis

B has them in all styles and for all voltages

From the simplest insulator for low voltages up to the large suspension units for 220,000 volts, O-B has a style of insulator proved by universal use and suitable for almost any problem of insulation.

The types shown here are representative of strain units for the lower voltages. They are made in a wide variety of forms with porcelain, composition and wood as the insulating material.

The Ohio Brass Co.
Mansfield Ohio, U. S. A.

New York—Philadelphia—Pittsburgh
Chicago—Charleston, W. Va.
Los Angeles—San Francisco—Paris, France

Do you remember when—

Russia and Japan went to war?

Roosevelt and Fairbanks were nominated?

The St. Louis Exposition was opened?

To do it you must turn your memory back about twenty years—two whole decades.

Well, several years before any of these notable events happened Willard already was busy making train lighting batteries for the railroads of the country.

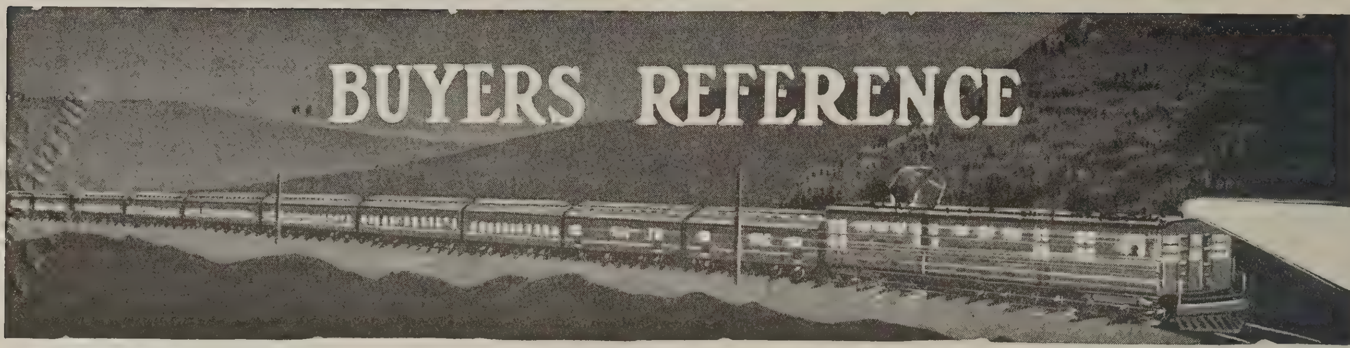
Electric lighting of trains was young in those days—the old gas lights were still in pretty general use.

Willard played a real part in developing the train lighting battery to its present state of excellence and in bringing about the universal acceptance of electrical train lighting.

Back of Willard Train Lighting Batteries are a seasoned organization and a wealth of experience.

Willard Storage Battery Company
Cleveland, Ohio

Willard STORAGE BATTERY



A. C. Floating Battery System
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Arc Welding Equipment
General Electric Co.
Westinghouse Electric & Mfg. Co.

Arrestors, Lightning
General Electric Co.
Westinghouse Electric & Mfg. Co.

Axle Pulleys
Dodge Manufacturing Corporation.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.

Axle Pulley Bushings
Dodge Manufacturing Corporation.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.

Ball Bearings, New and Reground
Ahlberg Bearing Co.

Batteries, Dry
National Carbon Co.

Batteries, Storage
Electric Storage Battery Co.
National Carbon Co.
Safety Car Heating & Lighting Co.
Western Electric Co.
Willard Storage Battery Co.

Battery Charging Apparatus
Anderson Mfg. Co., Albert & J. M.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Bearings, Axle Generator
Electric Storage Battery Co.
Oliver Electric & Mfg. Co.
S. K. F. Industries, Inc.
Safety Car Heating & Lighting Co.

Bearings, Ball
S. K. F. Industries, Inc.

Bearings, Ball, New and Reground.
Ahlberg Bearing Co.

Bearings, Ball Thrust
S. K. F. Industries, Inc.

Belting, Axle Generator
Goodrich Rubber Co., B. F.

Bonds, Rail
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Boxes, Fuse
Central Electric Co.
Chicago Fuse Mfg. Co.

Boxes, Junction and Outlet
Central Electric Co.
Chicago Fuse Mfg. Co.
Standard Underground & Cable Co.

Boxes, Switch
Central Electric Co.
Chicago Fuse Mfg. Co.
Electric Controller & Mfg. Co.

Brakes, Crane
Electric Controller & Mfg. Co.

Brakes, Disc
Electric Controller & Mfg. Co.

Brakes, Electric
Electric Controller & Mfg. Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Bridges, Signal.
Bates Expanded Steel Truss Co.

Brush Holders
Anderson Mfg. Co., Albert & J. M.

Brushes, Motor and Generator
National Carbon Co.

Brushes, Car Lighting, Generator
Electric Storage Battery Co.
National Carbon Co.
Safety Car Heating & Lighting Co.

Buffers
Valley Electric Co.

Cable, Armored and Lead Covered
Central Electric Co.
General Electric Co.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Rome Wire Company.
Standard Underground Cable Co.
York Insulated Wire Works.

Cable, Insulated
Central Electric Co.
General Electric Co.
Goodrich Rubber Co., B. F.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Rome Wire Company.
Standard Underground Cable Co.
York Insulated Wire Works.

Cable, Telephone
Central Electric Co.

Car Lighting Equipment
Electric Storage Battery Co., The
Oliver Electric & Mfg. Co.
Safety Car Heating & Lighting Co.

Carbon, Welding
National Carbon Co.

Carbons, Photographic
National Carbon Co.

Carbons, Projector
National Carbon Co.

Caustic Soda Cells
National Carbon Co.

Circuit Breakers, Carbon
General Electric Co.

Circuit Breakers, Oil
General Electric Co.
Westinghouse Electric & Mfg. Co.

Clamps and Connectors
Anderson Mfg. Co., Albert & J. M.
Chicago Fuse Mfg. Co.
General Electric Co.

Cleats
National Metal Molding Co.

Compressors, Air
General Electric Co.
Westinghouse Electric & Mfg. Co.

Conduit Fittings
Central Electric Co.
Chicago Fuse Mfg. Co.
Electric Controller & Mfg. Co.

Conduit, Flexible Metallic
Central Electric Co.
Electric Storage Battery Co.
National Metal Molding Co.

Conduit, Rigid
Central Electric Co.
Electric Controller & Mfg. Co.
National Metal Molding Co.

Contact Wire
Bridgeport Brass Co.

Control Apparatus, Car Lighting
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Westinghouse Electric & Mfg. Co.

Controllers, Automatic
Electric Controller & Mfg. Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Controllers, Crane
Electric Controller & Mfg. Co.
General Electric Co.

Controllers, Manual
Electric Controller & Mfg. Co.
General Electric Co.

Controllers, Machine Tool
Electric Controller & Mfg. Co.
General Electric Co.

Copper Rods and Tubes
Standard Underground Cable Co.

Couplings, Flexible
Nuttall Co., R. D.

Cutouts, Entrance
Chicago Fuse Mfg. Co.

Electrical Apparatus and Supplies
Bryant Electric Co., The
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electrification Construction Materials
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Electrification of Steam Roads
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electrodes
National Carbon Co.

Fans, Car
Central Electric Co.
General Electric Co.
Safety Car Heating & Lighting Co.
Westinghouse Electric & Mfg. Co.

Fans, Desk and Bracket
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Fixtures, Car Lighting
Central Electric Co.
Oliver Elec. & Mfg. Co.
Safety Car Heating & Lighting Co.

Fixtures, Locomotive Cab Lighting
Central Electric Co.
Oliver Electric & Mfg. Co.

Fixtures, Office, Shop and Yard Lighting
Central Electric Co.
Oliver Electric & Mfg. Co.
Westinghouse Elec. & Mfg. Co.

Floodlights
Central Electric Co.
General Electric Co.

Fuses, Cartridge
Central Electric Co.
Chicago Fuse Mfg. Co.
General Electric Co.

Fuses, Plug
Central Electric Co.
Chicago Fuse Mfg. Co.

Fuses, Refillable
Central Electric Co.
Chicago Fuse Mfg. Co.
General Electric Co.

Gears, Cut Tooth (Hardened Flexible Type)
Nuttall Co., R. D.

Generators, Axle Driven
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.

Generators, Car Lighting
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.

Generators, Power and Lighting.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Hangers, Catenary
Ohio Brass Co.

Headlight Reflectors and Cases
General Electric Co.
Sunbeam Electric Mfg. Co.

Headlight Turbo Generators
General Electric Co.
Sunbeam Electric Mfg. Co.

Headlights, Locomotive
Sunbeam Electric Mfg. Co.

Heavy Electric Traction
Bridgeport Brass Co.

Hose.
Goodrich Rubber Co., B. F.

Insulating Compounds
General Electric Co.
Standard Underground Cable Co.
Westinghouse Electric & Mfg. Co.

Insulating Materials
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Insulators
Ohio Brass Co.

Insulators, Catenary
Ohio Brass Co.

Insulators, Third Rail
Ohio Brass Co.

Jars, Battery
Electric Storage Battery Co.
Goodrich Rubber Co., B. F.
Safety Car Heating & Lighting Co.
Willard Storage Battery Co.

Lamp Guards
General Electric Co.

Lamps, Gauge
Central Electric Co.
Oliver Electric & Mfg. Co.

Lamps, Incandescent
Central Electric Co.
Western Electric Co.

Lighting Units, Indoor and Outdoor
Central Electric Co.
Pyle-National Co.
Westinghouse Elect. & Mfg. Co.

Lifting Magnets
Electric Controller & Mfg. Co.

Line Material
Bridgeport Brass Co.
Central Electric Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Locomotives, Electric
General Electric Co.
Westinghouse Electric & Mfg. Co.

Magnetizers
Valley Electric Co.

Mechanical Rubber Goods
Goodrich Rubber Co., B. F.

Molding, Metal
National Metal Molding Co.

Motors, A. C.
Electric Controller & Mfg. Co.
Fairbanks-Morse Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motors, D. C.
Electric Controller & Mfg. Co.
Fairbanks-Morse Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motor and Generator Brushes
National Carbon Co.

Motor Generator Sets
Electric Controller & Mfg. Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motor Cars, Gas-Electric
Fairbanks-Morse Co.
General Electric Co.

BUYERS REFERENCE

ALPHABETICAL INDEX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Out of the experienced past, into the exacting present, KERITE through more than a half-century of successful service, continues as the standard by which engineering judgment measures insulating value.
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